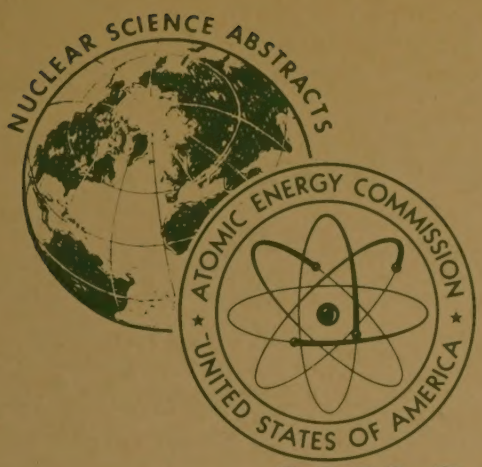

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Volume 15 Number 11

Abstracts 14047 – 15322

June 15, 1961

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Volume 15, Number 11 June 15, 1961

NUCLEAR SCIENCE ABSTRACTS

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Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.

TABLE OF CONTENTS

Volume 15, Number 11, June 15, 1961

Volume 15, Number 11 June 15, 1961

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

14047 (AECL-1168) ATOMIC ENERGY OF CANADA LIMITED [BROCHURE]. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1961. 11p.

Canada's main atomic research and development center is at Chalk River, Ontario, and is operated by the Government-owned Crown Company, Atomic Energy of Canada Limited. AECL is establishing a second nuclear energy research and development center on Winnipeg River, 60 miles northeast of Winnipeg, Manitoba, and midway between Lac du Bonnet and Seven Sisters Falls. The center is known as the Whiteshell Nuclear Research Establishment. Site preparations were started in 1960. A main objective of AECL is the development of economic nuclear power. Facilities and programs are reviewed. (C.H.)

14048 (BMI-1489(Rev.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING DECEMBER, 1960. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1961. Contract W-7405-eng-92. 79p.

Research areas include: reactor materials and components; alloy fuels; fission-gas release from refractory fuels; fuel-element development; gas-pressure bonding of ceramic, cermet, and dispersion fuel elements; development of uranium carbide; physical research; radioisotope and radiation applications; void-distribution and heat-transfer studies; development of uranium mononitride; materials development and evaluation; coated-particle fuel materials; problems associated with recovery of spent fuel elements; pebble-bed reactor materials; development of fabrication processes for cold bonding of Zircaloy-2 to type 410 stainless steel; development and evaluation of fuel elements for MGCR; development studies for SM-2; gas-cooled reactor program; corrosion of thorium and uranium under storage conditions; and gas-pressure bonding of beryllium-clad fuel elements. (For preceding period see BMI-1480.) (B.O.G.)

14049 (MND-P-2049) HAZARDS SUMMARY REPORT FOR A TWO WATT PROMETHIUM-147 FUELED THERMOELECTRIC GENERATOR. (Martin Co. Nuclear Div., Baltimore). June 1959. Decl. Sept. 19, 1960. 35p.

Discussions are included of the APU design, vehicle integration, Pm^{147} properties, shielding requirements, hazards design criteria, statistical analysis for impact, and radiation protection. The use of Pm^{147} makes possible the fabrication of an auxiliary power unit which has applications for low power space missions of <10 watts (electrical). (B.O.G.)

14050 (MND-P-2342) 100-WATT CURIUM-242 FUELED THERMOELECTRIC GENERATOR—CONCEPTUAL DESIGN. SNAP Subtask 5.7 Final Report. J. B. Weddell and Justin Bloom (Martin Co. Nuclear Div., Baltimore). May 1960. 66p. Contract AT(30-3)-217.

A thermoelectric generator which produces 100 watts of electrical power continuously over a six-month operational life in a space environment was designed. It employs the heat produced by the decay of Cm^{242} as the source of power. Uniform output over the operational life of the generator is accomplished by means of a thermally actuated shutter which maintains the hot junction temperature of the thermoelectric converter at a constant figure by varying the amount of surplus heat which is radiated directly to space from the heat source. The isotopic heat source is designed to safely contain the Cm^{242} under conditions of launch pad abort and rocket failure, but to burn up upon re-entry to the earth's atmosphere from orbital velocity. (W.L.H.)

14051 (RM-2665-AEC) THE EFFECT OF PLASTICITY ON DECOUPLING OF UNDERGROUND EXPLOSIONS. A. L. Latter, E. A. Martinelli, J. Mathews, and W. G. McMillan (RAND Corp., Santa Monica, Calif.). Nov. 22, 1960. Contract AT(11-1)-135. 28p.

The effect of plasticity, including work hardening, on decoupling underground explosions was studied both for cavities designed to give full decoupling according to the Geneva specification (70 cubic meters per ton of explosive energy) as well as small, overdriven cavities designed to give partial decoupling. An important result is that plasticity plays no role whatsoever for full-decoupling cavities, even those at great depth in which some plastic flow occurs during construction of the cavity. For overdriven cavities at great depth plasticity affects the decoupling factor by an amount which depends upon the degree of overdriving and the depth as well as the detailed stress-strain curve of the medium. A further result of the study is that for cavities at a depth of about one kilometer and in a medium like salt, which exhibits a reasonable amount of work hardening, the decoupling factor will be at least as great as that obtained in the overdriven Cowboy experiments and could be appreciably greater. To obtain more quantitative conclusions better stress-strain data are needed for loading conditions appropriate to the decoupling problem. Plastic flow associated with pressure transients was ignored here, but should be examined. (auth)

14052 (SCTM-53-61(14)) INSPECTOR ACCURACY: A STUDY OF THE LITERATURE. R. L. McCornack (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 30p.

A discussion is given of such studies made on the accuracy of industrial inspectors. Kinds of inspector bias are reported, and various measures of inspector accuracy de-

scribed. A new measure is suggested. General conclusions and specific problems are pointed out. Man considered as a monitor receives a short treatment, and some general comments on the state of studies in this area are ventured. (auth)

14053 (TID-7601) U. S. PAPERS [PRESENTED AT] FIFTH NUCLEAR CONGRESS, ROME, ITALY, JUNE 20-26, 1960. (Division of International Affairs, AEC). 98p.

A collection of the eight U. S. papers given at the Fifth Nuclear Congress is presented. Topics reported on include: aims and techniques of public information in nuclear plant activities, technical information for nuclear plant activities, production and separation of isotopes at ORNL, production at BNL of radioisotopes for medical purposes, characteristics and manufacture of radioisotopes for medical purposes at Argonne Cancer Research Hospital, programs at Donner and Lawrence Radiation Laboratories, physical quantities of importance in radiobiology, and radioepidemiology. (M.C.G.)

14054 (WAL-TR-920/1(60)) TECHNICAL REPORTING, 1960. Astric V. Gallagher, ed. (Watertown Arsenal Labs., Mass.). Jan. 1961. 48p.

Abstracts are included of published reports and notes in the fields of : I. Basic Research. physical metallurgy, refractory materials, erosion, mechanics, and principles of testing materials; II. Supporting Research. physical metallurgy, armor materials, materials for cannon and projectiles, heat- and erosion-resistant materials, and nondestructive testing; and III. Basic Production Engineering. ferrous metallurgy and nondestructive testing. A listing of 13 monographs is included. (B.O.G.)

14055 (AEC-tr-4480) SPACE POWER SYSTEMS. Translated by J. Woroncow from excerpts of Soviet Books: "From Artificial Satellites to Interplanetary Voyages," by A. Shternfel'd. State Publishing House of Literature on Physics and Mathematics, Moscow, 1959; and p.30-41 of "In a Rocket to the Moon," by V. I. Levantovskii (Levantovskiy). State Publishing House of Literature on Physics and Mathematics, Moscow, 1960. 11p. (XDC-61-1-109)

The application of nuclear energy for space propulsion, the American space propulsion concepts, and thermonuclear reactions and annihilation reactions as possible energy sources for space flight are discussed. (W.L.H.)

14056 (JPRS-6804) ALL-UNION CONFERENCE ON THE INTRODUCTION OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION INTO THE NATIONAL ECONOMY OF THE USSR. Translation of Atomnaya Energ., 9: 221-41 (Sept. 1960). 58p.

One-hundred-sixty-seven papers and reports were read. Translations are presented of selected articles covering the use of radioactive isotopes and nuclear radiation in surveying and developing mineral resources, in metallurgy, in ore concentration and mining industries, in construction, in light industry, in machine building, in agriculture, the food industry, in medicine, and the development of radiation sources for the control and automation in technological processes. (C.H.)

14057 THE SPREAD OF RADIOACTIVE CLOUDS AFTER THE FRENCH ATOMIC TEST IN THE SAHARA ON FEBRUARY 13, 1960. I. Brauer (Deutscher Wetterdienst, Offenbach (Main), Ger.). Atomkernenergie, 6: 25-9(Jan. 1961). (In German)

The nuclear test explosion in the French Sahara on February 13, 1960, was released under conditions which allowed the propagation of the nuclear cloud to be studied during the 15 day period following the explosion. A preconstructed trajectory surrounding the northern hemisphere was, in principle, verified. (auth)

14058 SUMMARY REPORT OF STRONG-MOTION MEASUREMENTS, UNDERGROUND NUCLEAR DETONATIONS. W. M. Adams (California Univ., Livermore), R. G. Preston, P. L. Flanders, D. C. Sachs, and W. R. Perret. J. Geophys. Research, 66: 903-42(Mar. 1961).

Subsurface and surface motion measurements were made on six underground nuclear detonations in the Oak Springs tuff of Nevada Test Site in Operation Hardtack II: Shots Mars (~13 tons), Tamalpais (~77 tons), Neptune (~155 tons), Logan (~5 kt), Evans (~30 tons), and Blanca (~19 kt). Free-field peak radial acceleration decreased as the inverse third or fourth power of slant range, as for Rainier. Particle velocities attenuated at a rate between the inverse square and inverse cube. Maximum radial and tangential subsurface stress varied as the inverse cube of radial range. Observed peak strain suggested attenuation at a rate between inverse cube and inverse square of range. Maximum upheaval at Blanca surface zero was about 25.5 feet; ~2.5 feet at 750 feet radial range; and 1.5 feet at 910 feet. Reed gage spectra indicated a shift of maximum energy to lower frequencies with increasing ground range. All components of surface acceleration followed an empirical equation of the form $A(g) = 3.2 \times 10^{6} W^{0.7}(kt) R^{-2}(ft)$. All components of surface displacement did not follow a comparable relationship. Displacement was more precisely predicted than acceleration. The velocity of the tuff was determined to be 6200 ft/sec, with the velocity of the underlying dolomite 11,700 ft/sec. Assuming a two-layer model for the crust beneath the Nevada Test Site, appropriate values for the thicknesses and velocities were 24 km and 5.69 km/sec for the top layer, and 36 km and 7.65 km/sec for the intermediate layer. The top of the mantle beginning at a depth of 60 km had a velocity of 8.12 km/sec and dipped eastward. (auth)

14059 PARTICLE MOTIONS NEAR EXPLOSIONS IN HALITE. Byron F. Murphey (Sandia Lab., Albuquerque, N. Mex.). J. Geophys. Research, 66: 947-58(Mar. 1961).

Peak particle velocities and displacements are measured for tamped (coupled) and cavity (decoupled) explosions in halite. Recordings are illustrated of particle velocity versus time in the salt medium and of pressure versus time on the cavity wall. Peak particle velocities from tamped shots decrease as $d^{-1.65}$ over distances equivalent to 40 to 800 feet for 1000 pounds of high explosive. Decoupling factors that are directly observed apply only to close-in stations. One method of extrapolating close-in data yields distant decoupling factors ranging from 40 to 100 for these particular experiments. Actual measurements of distant decoupling factors give larger numbers by a factor of 2. Extrapolation to nuclear explosions is not attempted here. (auth)

14060 USE OF LARGE CAVITIES TO REDUCE SEISMIC WAVES FROM UNDERGROUND EXPLOSIONS. Roland F. Herbst, Glenn C. Werth, and Donald L. Springer (California Univ., Livermore). J. Geophys. Research, 66: 959-78(Mar. 1961).

An analysis is given of an experiment designed to test the theory of seismic decoupling of underground explosions. The amplitude of the seismic signal from a 1.7-kt nuclear explosion in a hole in salt is calculated and compared with the measured value from the 1.7-kt Rainier shot in tuff at the same distance. A decoupling factor of about 300 results. The experiment, called Cowboy is designed to test the decoupling principle by carrying out a series of eight high-explosive shots in two spheres made in a salt dome, and nine tamped shots for comparison. The seismic data are obtained primarily at ranges of 14,000 and 22,000 feet and at frequencies of 10 to 30 cps. A salt-to-salt decoupling

actor of 100 is obtained which is consistent with the predicted tuff-to-salt factor of 300. When the sphere is overriven so that the walls do not move elastically (which iolates a condition of the theory for full decoupling), decoupling factors of 10 and 30 are measured. The seismic ata are interpreted to give the dependence of decoupling n the various parameters of the experiment. The decouling deduced from measurements made 80 feet from the hot points is found to be consistent with that deduced from he measurements at 14,000 and 22,000 feet. (auth)

14061 ATOMIC ENERGY RESEARCH IN THE LIFE AND PHYSICAL SCIENCES, 1960. A Special Report of the United States Atomic Energy Commission, January 1961. (Atomic Energy Commission, Washington, D. C.). 175p.

The basic research financed by the Atomic Energy Commission may be separated broadly into work in the life sciences and in the physical sciences. The life science program is directed primarily toward understanding the effects of ionizing radiation on living systems, developing effective methods for preventing or counteracting these effects, and developing uses of radiation and radioisotopes in medicine, biology, and agriculture. Physical science research is directed primarily toward determining the natural laws of the physical world relevant to development, use, and control of nuclear energy. Work in physical research covers physics and mathematics, chemistry, metallurgy and materials, and controlled thermonuclear processes. Research carried on during 1960 is described. A list is appended of current unclassified research contracts in physical and biological sciences. (C.H.)

14062 ELEMENTS OF NUCLEAR ENGINEERING. Glenn Murphy. New York, John Wiley & Sons, Inc., 1961. 223p., 1 illus. $7.50.

The objective of this book is to present a survey of the field of nuclear engineering for the purpose of indicating its scope, potentialities, and limitations. Chapters are included on: the engineer and nuclear energy, nuclei and nuclear reactions, radiation, reactor theory, engineering of nuclear power, radiation detection, shielding and radiation effects, and industrial uses of isotopes. (N.W.R.)

14063 IMPROVING THE AEC REGULATORY PROCESS. VOLUME I. VOLUME II. APPENDIX. (United States. Congress. Joint Committee on Atomic Energy). Mar. 1961. Vol. I, 85p.; Vol. II, 604p.

Volume I. A study was prepared by the staff of the Joint Committee on Atomic Energy of the United States Congress on regulatory processes of the Atomic Energy Commission. Results are presented together with an analysis of case histories in reactor licensing, materials licensing, and rulemaking. Certain problems in the AEC regulatory process are identified, alternative organizational arrangements are considered, and a plan is presented for the establishment of an atomic safety and licensing board within the AEC. It is concluded that an internal board with final licensing authority, not subject to the Commission review, and a role in the development of regulatory rules and standards, over which the Congress would retain final authority, would be best adopted to perform AEC regulatory functions for perhaps the next ten years. Details of the plan are discussed. Volume II. Selected materials are presented which bear on the AEC regulatory process, including correspondence and excerpts from the Atomic Energy Act of 1954 and AEC regulations. A report on the regulatory program of the Atomic Energy Commission, prepared by the AEC, is reproduced in its entirety and excerpts from other studies of the AEC regulatory process are also included. A selected bibliography on the AEC regulatory process is also included. (C.H.)

14064 INTRODUCTION TO NUCLEAR SCIENCE. Alvin Glassner. Princeton, N. J., D. Van Nostrand Co., Inc., 1961. 223p. $3.75.

A survey is given of nuclear science and its impact upon other natural and physical sciences. Following a review of atomic structure, a discussion is presented of recent detection methods and known forms of radiation. Descriptions are given of accelerators, nuclear reactions, the nucleus, and reactors. Applications of nuclear science in biology and chemistry are considered. Experimental demonstrations are included of fundamental phenomena and principles. An effort was made to strip the experiments of accessories and expensive equipment to allow their use in school and industrial laboratories. (B.O.G.)

General and Miscellaneous

14065 (AEC-tr-4527) BIOCHEMISTRY OF AUTOTROPHIC SULFUR BACTERIA. PART I. THE CYTOCHROMES AND HEMOPROTEIN ENZYMES IN THIOBACILLUS THIOPARUS AND THIOBACILLUS THIOOXIDANS. T. W. Szczepowski and B. Skarzynski. Translated for Oak Ridge National Lab. from Acta Microbiol. Polon. 1: 93-106 (1952). 37p. (Includes original, 14p.).

Two species of chemosynthetic, autotrophic bacteria were isolated from mineral waters which contain 51 to 68 mg/l of hydrogen sulfide and identified as Thiobacillus thioparus and Thiobacillus thiooxidans. Biochemical metabolic characteristics are described. (C.H.)

14066 (JPRS-7617) MEDICAL RADIOLOGY. Translation of Meditsinskaya Radiologiya, Volume 5, No. 9, 1960. 189p.

A complete translation is presented. Selected items were previously abstracted for NSA from the original. (C.H.)

14067 (UCRL-Trans-646) FORMATION OF AMINO ACIDS DURING THE ACTION OF ULTRAVIOLET RAYS ON THE SOLUTIONS OF FORMALDEHYDE AND AMMONIUM SALTS IN THE PRESENCE OF ADSORBENTS. T. E. Pavlovskaya, A. G. Pasynskii, and A. I. Grebenikova. Translated from Doklady Akad. Nauk S.S.S.R., 135: 743-6(1960). 11p. (includes original, 4p.).

The formation of amino acids by the action of ultraviolet light on solutions of formaldehyde and ammonium nitrate in the presence of various adsorbents and catalysts was studied. Optical quartz, bentonite, kaolinite, and limonite were used as absorbents. After irradiation the solution contained a complex mixture of inorganic and organic compounds. Separation and analysis of the mixture were carried out. Amino acids in final chromatograms were identified by comparison with tracers. Results are tabulated. The nature and relative content of various amino acids changed noticeably in the presence of the adsorbents. Possible reaction mechanisms involved in the formation of amino acids from the interaction of formaldehyde and ammonium salts under the influence of ultraviolet radiation are discussed. (C.H.)

14068 (UCRL-Trans-652) PHASE CONTRAST MICROSCOPIC AND ELECTRON MICROSCOPIC OBSERVATION OF MAST CELLS. Misao Hagihara. Translated from Acta Haematol., 23: 747-66(1960). 37p. (includes original, 11p.)

Mast cells of fetal and postfetal rats were studied comparatively by means of phase contrast as well as electron microscopy. Mature mast cells were found for the first time in week-old rats. Mast cells were observed to degenerate and decrease in number after the administration of histamine liberators such as distilled water, egg albumin, and lecithinase A. The microstructure of specific granules of mast cells was shown to differ from that of the basophilic leukocytes of the blood. (C.H.)

14069 ADVANCES IN APPLICATIONS OF RADIOISOTOPES IN PEDIATRICS. William A. Reilly (Univ. of California, San Francisco). Am. J. Roentgenol., Radium Therapy Nuclear Med., 85: 748-56(Apr. 1961).

There are many clinical problems which can be solved, at least partially, by the judicious employment of radioisotopically labeled compounds, elements, vitamins, etc. A brief discussion of some of the actual and possible uses of radioisotopes in pediatric practice is presented. 42 references. (auth)

14070 PHANTOM STUDIES IN SCANNING DIAGNOSTICS. W. Entzian (Neurochirurgische Universitatsklinik, Bonn). Atompraxis, 7: 7-10(Jan. 1961). (In German)

The test arrangement and equipment for scan recordings of phantom tumors are described. In the phantom arrangement, the concentration of R. I. is varied in both the "tumor" and the "environment." The size of the tumor and its distance from the detector are also varied. Certain relations between the activity concentration and the pulse rates measured over the "tumor" and the "environment" on the one hand, and the possibility of representing a tumor in a scan picture on the other hand, are discussed. A method is given for evaluating the resolving power of a scanning apparatus by means of an index line or characteristic. (auth)

14071 OBSERVATION OF TWO PHOTOREACTIONS IN PHOTOSYNTHESIS. M. B. Allen, L. H. Piette, and J. C. Murchio (Kaiser Foundation Research Inst., Richmond, Calif. and Varian Associates, Palo Alto, Calif.). Biochem. Biophys. Research Communs., 4: 271-4(Mar. 24, 1961).

Observations on the electron paramagnetic resonance signals from Chlorella pyrenoidosa during photosynthesis indicated that more than one pigment was activated by light. Two signals were resolved which differed in line width, relaxation time, and half life. Evidence is presented that one of these signals was induced by longer wave lengths of light, absorbed by chlorophyll a, and the other signal was induced by shorter wave lengths, absorbed by chlorophyll b. (C.H.)

14072 LIQUID-SCINTILLATION COUNTING OF C^{14}-LABELLED ANIMAL TISSUES AT HIGH EFFICIENCY. W. O. Brown and H. C. Badman (Queen's Univ., Belfast). Biochem. J., 78: 571-8(1961).

The counting of C^{14}-labelled substances, soluble and insoluble in the scintillator, at counting efficiencies of 90 and 60% respectively with a single photomultiplier liquid-scintillation-counting assembly operating at room temperature is described. The effect of scintillator volume on xylene-soluble sources and sources soluble in aqueous solutions was investigated. Phosphorescence quenching of the scintillator by organic solvents and by oxygen was examined. The importance of phosphorescence of the quartz counting vessel in determining count rates is indicated. A routine method is described for dissolving tissues and proteins by means of potassium hydroxide and a molar solution of Hyamine 10-X in methanol to produce solutions containing 10 mg of dry tissue/ml for liquid-scintillation counting. The use of Hyamine 10-X for blending sources soluble in aqueous solution with scintillator is described. The effect of both the volume of Hyamine 10-X solution used for blending, and of the sample, on counting efficiency was shown with [C^{14}]glycine solutions alone and with [C^{14}]glycine added to tissue solutions. The efficiency of the Hyamine 10-X blending method was demonstrated by measuring the re-

coveries of added counts, (as [C^{14}] glycine) from tissue and protein solutions. [C^{14}]Glycine dissolved in these solutions was counted at the same efficiency as in water solution. (auth)

14073 PRE-THERAPEUTIC PHYSICAL EXPERIMENTS WITH HIGH ENERGY PROTONS. Borje Larsson (Univ. of Uppsala). Brit. J. Radiol., 34: 143-51(Mar. 1961).

Methods of beam control and dosimetry for radiological work with a 187 Mev proton beam are described. The results of measurement of absorption and distribution of dose are reviewed with reference to the possible application of accelerated light atomic nuclei to radiotherapy of tumors and to intracranial radiosurgery. (auth)

14074 EFFECT OF HEAVY WATER ON THE NUCLEAR DIVISION OF CELLS IN CULTURE. Jean Lavillaureix (Faculté de Médecine, Strasbourg). Compt. rend., 252: 622-3(Jan. 23, 1961). (In French)

Heavy water blocks the mitoses of KB cells in culture at the prophasis and metaphasis stages. This inhibition is reversible if the concentration of heavy water is not too high and if the exposure is not too prolonged. (tr-auth)

14075 A COBALT MACHINE FOR SEMI-ACUTE IRRADIATION OF GROWING PLANTS. W. R. Singleton, A. Caspar, and W. S. Flory, Jr. (Univ. of Virginia, Boyce). Intern. J. Appl. Radiation and Isotopes, 10: 47-54(Feb. 1961). (In English)

A Co^{60} machine for irradiating growing plants with gamma rays is described. The 200-c machine is shielded behind earthen bunkers with concrete retaining walls, also a sky-shine shield intercepts vertical radiation. The radiation level at the control house, 100 ft away, is 2 mr/hr. The source is held in place by an electromagnet which is raised and lowered by a windlass in the control house by means of a stainless-steel cable. In case of power failure the Co^{60} source drops into the lead container in the center of the field. Either seeds, plants, or other biological specimens may be treated. Doses ranging from 7000 r/hr at 20 cm to 1 r/hr at 20 m may be used. At 1 m the dose is 310 r/hr or approximately 7300 r for a 23.5 hr day. A dose of 1000 r is sufficient for inducing many mutations in plant material. This can be obtained in 23.5 hr at about 3 m from the source. (auth)

14076 THE RADIOISOTOPE RENOCYSTOGRAM. Delores E. Johnson, George V. Taplin, Earl K. Dore, and Jane Hayashi (Univ. of California, Los Angeles and Los Angeles County Harbor General Hospital, Torrance, Calif.). J. Nuclear Med., 2: 8-23(Jan. 1961).

An optimum arrangement of external scintillation detection equipment for obtaining reliable renograms is described. Considerable latitude in this area is permissible. I^{131}-labeled Hippuran has been a major factor in the improvement of the radioisotope renogram. The conventional renogram has been developed into a multipurpose radiotracer test called the Hippuran I^{131} renocystogram. (auth)

14077 MEDICAL USE OF X-RAYS AND OTHER IONIZING RADIATIONS AS A HEALTH HAZARD. F. Petrovcic (General Hospital "Dr. Stojanovic", Zagreb). Lijecnicki vjesnik, 82: 3-13(1960). (In Yugoslavian)

A review is given of the amounts of radiation received by the gonads of a generation from various radiation sources. Special attention is paid to ionizing radiation hazards, both somatic and genetic, arising from the medical use of radiation. The doses received by the patient in the course of various x-ray examinations are reviewed. It is pointed out that the use of x rays for diagnostic purposes represents the largest source of radiation exposure. Indications for the diagnostic and therapeutic use of radiation should become stricter, and the procedures applied in radiology should be those involving the smallest possible doses. The lower part of the abdomen of young persons treated by radiation should be covered, and the gonads of the patients protected by special protective devices. The physician and the staff professionally exposed to ionizing radiation should also be protected. (auth)

14078 PROTECTION OF GONADS IN RADIOGRAPHIC DIAGNOSTICS. F. Petrovcic (General Hospital "Dr. Stojanovic", Zagreb). Lijecnicki vjesnik, 82: 133-9(1960). (In Yugoslavian)

Owing to the genetic effect of ionizing radiation, any gonad exposure of persons younger than 30 to 45 years is hazardous. One way to diminish the exposure of gonads, especially in the diagnostic use of x rays, is a direct protection by various devices made of lead or lead rubber. The following protective devices have been used: shields for the ovary, protective shells for the testis, protective spoon for children whose testes being situated shallowy in the scrotum cannot be protected by the shells, protective sheets on the x-ray apparatus tables, and protective screens designed both to protect the gonads and to reduce the body volume exposed to radiation during radiographic examinations of the thorax and the upper abdominal region. (auth)

14079 NONHOMOGENEOUS PHANTOM WHICH SIMULATES THE HUMAN BODY AND USE OF THIS PHANTOM IN RADIATION MEASUREMENT. Istvan Nikl (MAV Hospital, Budapest and Central Polyclinic, Budapest). Magyar Radiol., 12: No. 3, 133-41(Aug. 1960).

To ensure more exact measurement of radiation dosage, a phantom was constructed using a paraffin-soaked human skeleton as the armature. The fleshy parts of the body were molded from a paraffin composition, while the lungs were made of pressed corkwood. This phantom shows the same x-ray absorption as human tissue up to a dosage of 200 kilovolts. The x-ray pictures obtained proved to be identical with those taken of humans. Comparative measurements showed that the nonhomogenous phantom is quite reliable for the determination of radiation dosage administered either to the surface or deep inside. The phantom is also useful in gauging the intensity of radiation needed for diagnostic and therapeutic purposes and makes a good medium for investigating radiation protection measures. (TCO)

14080 TECHNICAL CONSIDERATIONS IN SCINTILLATION SCANNING OF THE HUMAN SPLEEN. Philip M. Johnson and John C. Herion (Univ. of North Carolina, Chapel Hill). Radiology, 76: 438-43(Mar. 1961).

Two methods of preparing isologous or compatible homologous red cells for splenic scintillation scanning are described. Application of these methods in 30 subjects, including 18 with splenic abnormalities, has resulted in satisfactory splenic area scans in all but 4 after rapid deposition of prepared radioactive red cells primarily in the spleen. (auth)

14081 DOSE TO THE EYE FROM RADIOGRAPHIC PROCEDURES. Elizabeth F. Focht, George R. Merriam, Mary Barnes, and John A. Evans (New York Hospital-Cornell Medical Center, New York and Columbia-Presbyterian Medical Center, New York). Radiology, 76: 459-63 (Mar. 1961).

Measurements were made of the radiation dose received by the eye during various standard diagnostic x-ray examinations in which the eye is in the direct beam. A special phantom head, a dental x-ray machine, and an ionization chamber were used in the measurements. Results are tab-

ulated. None of the diagnostic procedures delivered significant doses of radiation to the lens. (C.H.)

14082 CLINICAL USE OF RADIOISOTOPES. A Manual of Technique. Second Edition. Theodore Fields and Lindon Seed, eds. Chicago, The Year Book Publishers, 1961. 475p.

Eighteen specialists in the field of nuclear medicine contributed to this description of currently accepted clinical procedures. Topics covered include routine clinical diagnostic tests using radioisotopes, routine clinical therapy techniques employing beta and gamma sources, and a section on planning and operating a radioisotope laboratory. The procedures included are those which are representative of the techniques giving the most accurate results in the experience of the editors. Statistical data and examples of record and report sheets are appended. Comprehensive bibliographies and a complete subject index are included. (C.H.)

14083 RADIATION PROTECTION AND RECOVERY. Alexander Hollaender, ed. International Series of Monographs on Pure and Applied Biology. Division: Modern Trends in Physiological Sciences. New York, Pergamon Press, 1960. 397p. $10.00.

Papers are included which treat various aspects of protection and recovery from radiation injury at all levels of biological organization (molecular, cellular, and organismal). Separate abstracts have been prepared for three of the papers. The others have been previously abstracted in Nuclear Science Abstracts. (D.L.C.)

14084 PROTECTION OF MACROMOLECULES IN VITRO AGAINST DAMAGE BY IONIZING RADIATIONS. Peter Alexander (Royal Cancer Hospital, London). p.3-44 of "Radiation Protection and Recovery." Alexander Hollaender, ed. New York, Pergamon Press, 1960.

The steps in the absorption of ionizing radiations by cells and the formation of the final biological injury are discussed. Direct and indirect actions of radiations are discussed; it is concluded that direct action cannot be ignored even in systems consisting mostly of water. Various possible mechanisms are discussed: diverting the energy from one molecule to another and repair of damaged molecules while still in the labile state. The self-protective effect is discussed in which macromolecules inactivated by radiation continue to compete for free radicals. The oxygen effect is also treated. The decrease of the protective and oxygen effects by increasing ionization density is explained as due to the protective agent concentration being too low to capture all the free radicals produced by intense radiation. Some examples of protection against indirect action are given for enzymes, viruses, nucleic acids, and synthetic polymers in aqueous solution. Protection against direct action in the solid state is discussed for polymethyl methacrylate, and it is believed that in this case, the ionization is not localized and travels along the molecule as an electron hole until it is adjacent to a protector with which it undergoes a charge transfer. If this mechanism is correct, then the calculation of target size is of doubtful value. Some observations are presented for direct protection in viruses, nucleic acids, and proteins. The evidence is in favor of the view that in vivo the protective agents reduce the initial radiochemical damage by protecting a key macromolecule against the direct or indirect action of radiation. The relation of the protective effect to the oxygen effect is discussed, and the oxygen hypothesis (protection is a consequence of protective agent-oxygen reaction) is criticized. (D.L.C.)

14085 PROTECTION AND RECOVERY FROM IONIZING RADIATION: MECHANISMS IN SEEDS AND ROOTS. D. Davidson (Oak Ridge National Lab., Tenn.). p.175-211 of "Radiation Protection and Recovery." Alexander Hollaender, ed. New York, Pergamon Press, 1960.

The effects of ionizing radiations on roots are reviewed with respect to chromosome breakage, growth, site of damage, and protective agents. The results indicate that in roots, sites sensitive to radiations occur in nuclei and cytoplasm. Groups of cells of low radiation sensitivity occur in meristems. Protection against x and γ rays is achieved by oxygen removal before irradiation, and restorative processes are more effective in the presence of oxygen. Seeds are more radiation-resistant than growing roots, and possible ways of modifying radiation effects on seeds and the factors involved are discussed, e.g., water content, temperature, oxygen, and radiations of different linear energy transfer values. (D.L.C.)

14086 GENETICAL PROTECTION. Alan D. Conger (Univ. of Florida, Gainesville and Oak Ridge National Lab., Tenn.). p.212-41 of "Radiation Protection and Recovery." Alexander Hollaender, ed. New York, Pergamon Press, 1960.

Spontaneous mutations are discussed; it has been found that spontaneous mutations occur at a constant rate with time. For radioinduced mutations, the yield increases linearly with dose, with a few exceptions (ultraviolet), and the effect of intensity on mutation yield is usually negligible, except in the case of spermatogonial and oocyte stages. The effects of different radiations, species, strains, and sex are treated. The factors involved in the mutation rate are discussed: temperature, pre- or post-treatments with infrared or ultraviolet, chemicals, and biological and physiological treatments. Genetic protection is usually less than other kinds of protection, but protection may be obtained by disposing of the radioinduced mutagens or by interfering with their interaction with the gene. (D.L.C.)

14087 RADIOACTIVE SUBSTANCES IN THE BIOSPHERE. (International Atomic Energy Agency, Vienna). Mar. 1961. 43p. (STI/PUB/28)

Procedures are presented for collecting and analyzing samples for the determination of trace amounts of radioactive substances in water, air, food, and human material. The procedures are designed primarily to provide detailed instructions for determining the total level of radioactivity over large areas. Procedures are also included for the determination of various nuclides of special biological interest such as I^{131}, Cs^{137}, Sr^{89}, and Sr^{90}. (C.H.)

Biochemistry, Nutrition, and Toxicology

14088 (TID-11364) THE EFFECTS OF CONTINUAL Sr^{90} INGESTION DURING THE GROWTH PERIOD OF THE BEAGLE AND ITS RELATION TO Ra^{226} TOXICITY. Third Annual Progress Report, 1959-60. (California. Univ., Davis. School of Veterinary Medicine). Sept. 1960. Contract AT(11-1)-GEN-10. 87p.

Progress is reported in a study on the effects of continuous ingestion of Sr^{90} during the growth period of beagles and its relation to Ra^{226} toxicity. Results will be extrapolated to the effects of continuous exposure of humans to Sr^{90}. Results of preliminary studies indicate that Sr^{90} is not discriminated against when fed daily at a constant Co/Sr ratio. The death of a beagle from a highly malignant

radioinduced osteosarcoma gave evidence of the pathological effects of Sr^{90} when fed daily. The objectives of the program are discussed and buildings and facilities are described and illustrated photographically. A literature review on the properties and metabolism of strontium was completed. (C.H.)

14089 (UCRL-9373) STUDIES ON THE CARBOXYDISMUTASE SYSTEM AND RELATED MATERIALS (thesis). Ning G. Pon (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1960. Contract W-7405-eng-48. 195p.

An enzyme system was studied from the standpoint of the purification and properties of one of its substrates, ribulose-1,5-diphosphate (RuDP), and the enzyme, carboxydismutase. The course of the reaction was followed by counting the acid-stable, nonvolatile fixation of C^{14} from labeled bicarbonate when incubated with unlabeled RuDP and the enzyme; the product was found to be 3-phosphoglycerate (3-PGA). ($RuDP + HCO_3^- \rightarrow 3\text{-}PGA + H^+$.) Divalent metal ions which were required for full enzyme activity are Ni^{2+}, Mn^{2+}, Co^{2+}, and Mg^{2+}, and some compounds were found which inhibited the reaction. The results indicate that the activation of the enzyme involves the unfolding of the protein prior to metal ion binding, that Mg^{2+} is the true cofactor for carboxydismutase, that the actual carboxylating species is dissolved CO_2 and not bicarbonate, and that the formation of an enzyme–metal ion–bicarbonate complex is required prior to the carboxylation of RuDP. The reaction of RuDP with cyanide was also studied and found to give a product tentatively identified as the diphosphate of hamamelonic acid and its epimer and not the cyanohydrin. (D.L.C.)

14090 BONE RESORPTION AND Ca^{45} TURNOVER IN GROWING RATS. Henry Jeffay and Harold R. Bayne (Univ. of Illinois, Chicago). Am. J. Physiol., 200: 335-40(Feb. 1961).

A group of rats were maintained on a Ca^{45} diet for 21 days, then sacrificed at varying time intervals after substituting a nonradioactive diet. The total calcium and calcium specific activity of several bones, blood, and urine were determined. After correcting for the dilution of radioactivity due to an increase in total bone calcium, it was found that there was little, if any, loss of Ca^{45} from rapidly growing bones. When the growth of the bone decreased, a small measurable loss was detected. It was assumed this slow loss of Ca^{45} represented bone resorption. Values for the rate of bone resorption are presented and their significance in the growth of the bone discussed. (auth)

14091 DETERMINATION OF N^{15} IN AMINO ACID MIXTURES WITHOUT SEPARATION INTO INDIVIDUAL COMPONENTS. K. Biemann and G. G. J. Deffner (Massachusetts Inst. of Tech., Cambridge, Mass.). Biochem. Biophys. Research Communs., 4: 283-7(Mar. 24, 1961).

A procedure is described for the spectrographic determination of N^{15} in amino acid mixtures. The procedure is simple and does not require the separation of amino acids from other nitrogen-containing substances. (C.H.)

14092 DETERMINATION OF THE DISTRIBUTION OF I^{131} IN BIOSYNTHETICALLY LABELLED [I^{131}] THYROXINE ISOLATED FROM THE THYROID GLANDS OF RABBITS AND RATS. L. G. Plaskett (University Coll. Hospital Medical School. London). Biochem. J., 78: 649-52(1961).

The diazo-coupling technique for determining the distribution of I^{131} between the two rings of the thyroxine molecule was applied to radioactive thyroxine purified from animal thyroids, and in one instance from a human thyroid. The results indicate that from the earliest time after administration when thyroxine samples could be obtained, the radioactive atoms were equally distributed between the rings of the thyronine nucleus. (auth)

14093 STUDIES ON THE DEGRADATION OF THYROID HORMONES IN VITRO WITH COMPOUNDS LABELLED IN EITHER RING. L. G. Plaskett (University Coll. Hospital Medical School, London). Biochem. J., 78: 652-7(1961).

When I^{131} labeled thyroxine was incubated with extracts of rat liver, it was found that deiodination from the thyroxine α ring occurs very slightly or not at all. Experiments with [3′:5′-I_2^{131}] thyroxine confirmed previous findings that the iodine atoms on the β ring are released as inorganic iodide. Organic metabolites were produced which adhered to the protein of the liver extract. These contained the iodine from the α ring, since on treatment with alkali they yielded 3:5-di-iodotyrosine and 4-hydroxy-3:5-di-iodophenyl-lactic acid. The possible identity of these metabolites is discussed. (auth)

14094 DETERMINATION OF THE DISTRIBUTION OF I^{131} IN BIOSYNTHETICALLY LABELLED [I^{131}] TRI-IODOTHYRONINE ISOLATED FROM THE THYROID GLANDS OF RABBITS. L. G. Plaskett (University Coll. Hospital Medical School, London). Biochem. J., 78: 657-60(1961).

Radioactive tri-iodothyronine was isolated from the thyroid glands of rabbits 24 hr after administration of I^{131} iodide. It was established that the labelling of this tri-iodothyronine was such that the specific radioactivity of the iodine on the two rings was equal. This finding is discussed in relation to the possible pathways of tri-iodothyronine biosynthesis. It is consistent with the view that tri-iodothyronine is formed by the deiodination of thyroxine. (auth)

14095 MODIFICATION OF THE RESORPTION OF RADIOCERIUM FROM AN INTRAMUSCULAR INJECTION BY DIETHYLENETRIAMINEPENTAACETIC ACID. A. Catsch and H. Kiefer (Kernforschungszentrum, Karlsruhe, Ger.). Experienta, 17: 22-3(Jan. 15, 1961). (In German)

It is shown in experiments on rats that the absorption of radiocerium from the site of an intramuscular injection and its excretion from the organism can be enhanced to a large extent by intraperitoneal administration of diethylenetriaminepentaacetic acid. (auth)

14096 STUDIES WITH RADIOACTIVE YTTRIUM IN FLIES. I. RETENTION AND DISTRIBUTION IN DROSOPHILA AFTER INJECTION. Per Oftedal (Norwegian Radium Hospital, Montebello, Norway). Intern. J. Radiation Biol., 3: 211-21(Mar. 1961). (In English)

After injection into Drosophila melanogaster males, Y^{91} citrate is completely retained. The pattern of distribution is shown to depend upon the injection site, and upon the age of the fly at the time of injection. Microscopically, it is shown that two alternative patterns of distribution occur. The radioactivity is concentrated either in the pericardial cells and the thoracic nephrocytes, or in the hemocytes. The mechanism deciding which of these patterns will obtain is discussed. It is presumed that it depends upon the type of aggregate formed when the Y^{91} citrate is prepared from the solution of $Y^{91}Cl_3$. The findings are discussed, but no definitive explanation can be given. (auth)

14097 STUDIES WITH RADIOACTIVE YTTRIUM IN FLIES. II. RETENTION AND DISTRIBUTION IN DROSOPHILA AND IN MUSCA AFTER INGESTION. Per Oftedal (Norwegian Radium Hospital, Montebello, Norway). Intern. J. Radiation Biol., 3: 222-30(Mar. 1961). (In English)

After ingestion, retention of Y^{91} citrate falls to a few per cent after two to three days in Drosophila, a week in Musca.

This retained radioactivity forms a tail on the retention curve. The retention site in Drosophila is shown to be a narrow band of cells in the endodermal mid-gut immediately anterior to the transition to the ectodermal hind-gut. In some flies, there is also a more diffuse and somewhat wider zone containing radioactivity in the middle mid-gut. There is no activity in the pericardial cells, or in the Malpighian tubules. In Musca there is no activity in the pyloric region, but most of the activity is found in a region in the middle mid-gut. This zone is situated about one-third anteriad from the pyloric region, and covers 10 to 25% of the total mid-gut length. Also, the pericardial structures contain some 5 to 15% of the total activity. The findings are discussed. (auth)

14098 SITE OF BINDING OF CHROMIUM-51 TO HAEMOGLOBIN. Howard A. Pearson and Kenneth M. Vertrees (U. S. Naval Hospital, Bethesda, Md.). Nature, 189: 1019-20(Mar. 25, 1961).

Results from experiments using two different methods showed that Cr^{51} was attached to hemoglobin largely on the beta chains. Since the Cr^{51} remained with the beta chain during dissociation and recombination, this may be used as a useful tool for localizing altered polypeptide chains of abnormal hemoglobin. (C.H.)

14099 METABOLIC FRACTIONATION OF C^{13} & C^{12} IN PLANTS. Roderic Park and Samuel Epstein (California Inst. of Tech., Pasadena). Plant Physiol., 36: 133-8(Mar. 1961).

C^{13}/C^{12} ratio analyses of chemical fractions from several plant phyla show that in all cases the lipid fraction is enriched in C^{12} compared to the whole plant. The C^{13}/C^{12} ratio of the plant lipids corresponds roughly to the C^{13}/C^{12} ratio of petroleums. The C^{12} enrichment in petroleums as compared to present day plants can be explained if selective preservation of plant lipids occurred during the sedimentation process. The degree of C^{12} enrichment in the plant lipid fraction is inversely related to the amount of lipid in the plant. The C^{12} enrichment which occurs in plant lipids may be balanced by the C^{13} enrichment which occurs in respired CO_2. Isotope selection at the level of acetate or pyruvate is a possible mechanism for explaining our results. (auth)

14100 DISTRIBUTION OF RADIOACTIVE IODINE IN TUMOURS OF THE THYROID GLAND. M. F. Merkulov, V. K. Modestov, N. P. Maslov, and I. A. Poberii (Central Medical Postgraduate Inst., Moscow and Herzen State Oncological Inst., Moscow). Problems Oncol. (U.S.S.R.) (English Translation), 6: 1275-83(1960).

Results from an autoradiographic investigation into the distribution of protein-bound compounds of radioactive iodine in ten thyroid gland tumors indicate absence of any fundamental difference in uptake of isotope as between malignant and benign tumors. There is a direct relation between the level of uptake of protein-bound iodine in individual tumors and the amount of intact follicular structures and their content of colloid. Iodinated proteins were not detected at the sites of dense cellular tumor growth. Large differences are noted in the level of uptake of protein-bound compounds of radioactive iodine among the different follicles. Uptake of radioactive iodine is as a rule inversely proportional to the size of the follicles. However, in thyroid gland tumors one may encounter not only large functioning but also small inactive follicles. The inequality of uptake of radioactive iodine by the different follicles would suggest the existence of phasic changes in intrafollicular iodine metabolism. (auth)

Fallout and Ecology

14101 (A/AC.82/G/L.302) Cs 137 IN SWEDISH MILK; RESULTS UP TO JUNE 1959. K. Löw (Sweden. Försvarets Forskningsanstalt, Stockholm). Sept. 1959. 5p.

The Cs^{137} content of dried milk samples manufactured during 1958 and 1959 was determined by means of γ spectrometry. The results of these and earlier measurements indicate a pronounced seasonal variation. The level in June 1959 is about 70 pc/g K. Data are tabulated. (auth)

14102 (NP-9984) ASSAY OF STRONTIUM-90 IN HUMAN BONE IN THE UNITED KINGDOM, FURTHER RESULTS FOR 1959. Medical Research Council Monitoring Report Series No. 1. (Gt. Brit. Medical Research Council, London). Nov. 14, 1960. 18p.

Measurements were made of levels of natural and radioactive strontium in samples of human bone collected during 1958 and 1959 from three areas of Great Britain. Data are tabulated. (C.H.)

14103 STUDIES ON THE LESSENING OF THE STRONTIUM UPTAKE OF PLANTS FROM THE SOIL. E. Welte, A. Kloke, and U. Marckwordt (Biologische Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, Ger.). Atompraxis, 7: 3-7(Jan. 1961). (In German)

Pot and aqueous-culture tests with inactive strontium were used to show that lime and magnesium fertilizers can lessen the uptake of Sr^{90} only in soils with extremely small calcium contents. (auth)

14104 THE NATURAL RADIOACTIVITY OF VARIOUS FOOD PRODUCTS IN THE ARMENIAN SSR. L. E. Mkrtchian (Yerevan Medical Inst., Armanian SSR). Izvest. Akad. Nauk Armyan. S.S.R., 13: No. 6, 65-9(June 1960).

Measurements were made on the radioactivity of 429 samples of different foods collected in Armenia. The levels of radioactivity were found to be within the limits of background radiation. (TCO)

14105 SOME CONSIDERATIONS OF PRESENT BIOSPHERIC CONTAMINATION BY RADIOACTIVE FALLOUT. Wright H. Langham (Los Alamos Scientific Lab., N. Mex.). J. Agr. Food Chem., 9: 91-4(Mar.-Apr. 1961).

Strontium-90 and Cs^{137} fall-out from nuclear weapons tests through October 1958 and entry of these radionuclides into the food chain are summarized. Total production of Sr^{90} and Cs^{137} has been about 9 and 14 Mc, respectively. Surface deposition levels will reach a maximum in about 1961. Both radionuclides have entered the food chain and man. Levels in man are lower, however, than predicted by ecological models based on 100% entry via plant uptake from the soil. It is not possible to estimate equilibrium levels in man and his foods with respect to integrated surface deposition levels. Calculation of radiation doses from Sr^{90} plus Cr^{137} to children born at the time of maximum fall-out (assuming ecological equilibrium at approximately twice the 1958 levels) indicates respective maximum 30-year genetic and 70-year bone and bone marrow exposures that will be about 2, 9, and 4% of that from average natural background. If a linear dose-response relationship is accepted, fall-out may increase the incidence of radiation-induced genetic, bone, and bone marrow disease in this generation by 2, 9, and 4%, respectively, of that resulting from natural background exposure. (auth)

14106 AVAILABILITY OF EXCHANGEABLE AND NONEXCHANGEABLE STRONTIUM-90 TO PLANTS. Howard Roberts, Jr. and Ronald G. Menzel (U. S. Dept. of Agriculture, Beltsville, Md.). J. Agr. Food Chem., 9: 95-8(Mar.-Apr. 1961).

Exchangeable and nonexchangeable fractions of strontium-90 were determined in soil samples taken from the plow layer of cultivated fields in the coastal plain of North Carolina in June 1955 and December 1958. Exchangeable strontium-90 contents averaged about 10 and 50 μμc per kg of soil on the two sampling dates, respectively. Nonexchangeable strontium-90 averaged 4 and 7 μμc, respectively. Lower amounts of both fractions of strontium-90 were recovered in samples extracted after dry storage for 1 year. The uptake of strontium-90 and calcium from these soils was studied by growing cowpeas in the greenhouse. From 8 to 18% of the exchangeable strontium was taken up, depending on the uptake of exchangeable calcium. Use of discrimination factors to determine availability of nonexchangeable strontium-90 to plants is discussed. Nonexchangeable strontium-90 apparently made little or no contribution to uptake. (auth)

14107 DEPTH OF FEEDING AS IT AFFECTS THE CONCENTRATION OF RADIOACTIVITY WITHIN THE PLANT. C. W. Christenson and Eric B. Fowler (Los Alamos Scientific Lab., N. Mex.). J. Agr. Food Chem., 9: 98-100(Mar.-Apr. 1961).

In any study of fall-out uptake by plants the depth at which the plant receives its nutrients at different time of growth is important. This study shows that in grass, alfalfa, and lettuce the roots were feeding below 20 inches after 46 days and since the fall-out is concentrated near the soil surface, only a small portion of the fall-out material will be translocated to the plant. This indicates that the major portion of fall-out material in plants is due to foliar absorption. This study also shows that the projection of concentration of radionuclide in soil to concentration of radionuclide in man is quite difficult since the uptake of the radionuclide by plant and hence, to man, can vary by a factor of 2 or 3, depending on the depth of feeding of the plant. (auth)

14108 UPTAKE OF RADIOACTIVE FISSION PRODUCTS BY CROP PLANTS. Hideo Nishita, E. M. Romney, and K. H. Larson (Univ. of California, Los Angeles). J. Agr. Food Chem., 9: 101-6(Mar.-Apr. 1961). (UCLA-459)

The uptake of several radioactive fission products from contaminated soils by crop plants through the root system, the distribution of the absorbed radioisotopes within plants, and some factors that modify the uptake and distribution of these radioisotopes in plants are discussed. The relative order of magnitude of uptake of fission products by plants appeared to be $Sr^{89,90} \gg I^{131} > Ba^{140} > Cs^{137}$, $Ru^{106} > Ce^{144}$, Y^{91}, Pm^{147}, Zr^{95}–Nb^{95}. There were considerable differences in uptake among different plant species and conditions of growth. Accumulation of each of the fission products studied was greatest in leaves, but comparatively low in seeds, fruits, or edible roots. Fission product contents of plants may be altered by certain soil management practices such as cultivation, fertilization, and organic matter application. (auth)

14109 ABSORPTION OF RADIONUCLIDES BY ABOVEGROUND PLANT PARTS AND MOVEMENT WITHIN THE PLANT. H. B. Tukey, S. H. Wittwer, and M. J. Bukovac (Michigan State Univ., East Lansing). J. Agr. Food Chem., 9: 106-13(Mar.-Apr. 1961).

The aboveground parts of plants readily absorb radionuclides from external spray applications. Entry occurs through the leaves, stem, fruit, and bark. The rate of absorption, extent of subsequent transport, and pattern of distribution within the plant is dependent upon the nature of the radionuclide and many internal and external factors. Not only are radionuclides absorbed by aboveground plant parts, but they may be lost therefrom into the external environment from leaching induced by rain and dew. Both acropetal and basipetal transport occur following application of P^{32}, K^{42}, Rb^{86}, and Cs^{137} to aerial plant parts. This is in marked contrast to Ca^{45}, Sr^{89}, Sr^{90}–Y^{90}, Ru^{103}, and Ba^{140}. These latter radionuclides do not move freely from the absorbing aerial organ (leaf, fruit), and basipetal transport is negligible. The hazard exists that fission product radionuclides may be directly incorporated into plant tissues. (auth)

14110 DIETARY CONSIDERATIONS OF THE RADIONUCLIDE CONTAMINATION OF NONMILK FOODS. R. H. Wasserman and C. L. Comar (State Univ. Veterinary Coll., Ithaca, N. Y.). J. Agr. Food Chem., 9: 113-16(Mar.-Apr. 1961).

Several factors and concepts that may contribute to an understanding of the food contamination problem with Sr^{90} and Cs^{137} are reviewed. In this country at the present time, milk and milk products contain the highest relative proportion of these fission products; however, nonmilk foods, especially vegetables and cereals, contribute more Sr^{90} to the total diet when considered as an entity. In the future, assuming no further testing, nonmilk foods will become even more important as sources of Sr^{90} for reasons discussed. Since Cs^{137} in milk and meat arises from a similar precursor (bovine serum), and since there is no apparent discrimination between these compartments, the relative contribution from these two major dietary sources of Cs^{137} is not expected to change with time. The variability in the radionuclide content of foods was emphasized by reference to the Minnesota wheat situation of several months ago. (auth)

14111 RADIONUCLIDES IN MILK. J. E. Campbell, G. K. Murthy, C. P. Straub, K. H. Lewis, and J. G. Terrill (Robert A. Taft Sanitary Engineering Center, Cincinnati). J. Agr. Food Chem., 9: 117-22(Mar.-Apr. 1961).

Monthly milk samples from the milk sheds serving Atlanta, Austin, Chicago, Cincinnati, Fargo-Moorhead, New York City, Sacramento, Salt Lake City, Spokane, and St. Louis were analyzed for Ca and K content, I^{131}, Ba^{140}, Cs^{137}, Sr^{89}, and Sr^{90}. Analysis of variance applied to these data indicated geographical and seasonal variations. The average Sr^{90} and Cs^{137} content of milk samples from Sacramento was the lowest, while that from St. Louis was the highest. The remaining stations were grouped into one of two intermediate categories. Samples collected during early spring and fall showed higher Sr^{90} and Cs^{137} than at other times, probably associated with changes in seasonal feeding practices. No relationship was observed between the concentration of Sr^{90} and Cs^{137} in milk and publicly announced weapons tests. In contrast, a direct relationship was observed between the weapons tests and the concentration of I^{131}, Ba^{140}, and Sr^{89}, which was influenced by the half life of the radionuclides, the meteorological conditions, and the geographical location of the sampling stations with respect to the test site. Observed concentrations of radionuclides were below maximum permissible concentrations. Impracticability of estimating concentration of Sr^{90} in milk, in terms of gross β-activity or Cs^{137}, is discussed. (auth)

14112 RADIONUCLIDES IN MAN FROM NUCLEAR TESTS. J. Laurence Kulp (Columbia Univ., Palisades, N. Y.). J. Agr. Food Chem., 9: 122-6(Mar.-Apr. 1961).

The results of recent experimental work in the determination of the stratospheric inventory of fission products—i.e., the fraction of Sr^{90} and Cs^{137} taken up directly from rain—and new measurements of the concentration of Sr^{90} in human bone make possible a more accurate prediction

of the future radiation doses to the world population. It is concluded that the U. S. diet has passed its peak concentration of Sr^{90} and Cs^{137}, that Sr^{90} probably will remain the largest contributor to the radiation dose to an individual, and that Cs^{137} measurement can be used to monitor Sr^{90} in milk in emergency situations. These results also suggest that in the event of large-scale nuclear warfare, the general radioactive contamination would not preclude the existence of large populations if short time (6 to 12 months) survival were possible. (auth)

14113 DETERMINATION OF FALLOUT CESIUM-137 IN ANIMAL AND PLANT TISSUES. Clifton Blincoe (Univ. of Nevada, Reno). J. Agr. Food Chem., 9: 127-9(Mar.-Apr. 1961).

Cesium-137 is one of the principal fall-out contaminants in agricultural products. A method is reported for its determination in plant and animal tissues. Cesium-137 is separated from ashed samples by coprecipitation with cobaltous cobalticyanide and measured with a single-channel γ spectrometer. An alkaline earth fraction suitable for Sr^{90} analysis is available. The method uses conventional equipment and is adaptable to parallel determinations on large numbers of samples. (auth)

14114 STRONTIUM-90 IN HUMAN TEETH. F. E. Butler (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nature, 189: 348-9(Mar. 11, 1961).

Measurements were made of the Sr^{90} content of 121 teeth collected in 1959. After a number of analytical steps, the final Sr^{90} content was determined by counting carrier-free Y^{90} daughter. A statistical analysis of results indicates that there is a definite inverse correlation between Sr^{90} concentration and age. The results for teeth were compared with those for bone at similar ages. A similar trend was found. (C.H.)

14115 SOME FACTORS INFLUENCING THE FOOD-CHAIN TRANSPORT OF RADIOACTIVE MATERIALS INTO COW'S MILK. D. Merten (Bundesforschungsanstalt fur Milchwirtschaft, Kiel) and O. Suschny. Nature, 189: 806-8 (Mar. 11, 1961).

Variations in the radioactive content of milk have been attributed to seasonal influences, changes in feeding practices, varying contamination rates, and other factors. Three model cases are presented which illustrate three combinations of basic conditions which influence the transport of radioactive materials from fall-out into cow's milk. It is assumed that the cows are fed on hay or grass which has been exposed to radioactive contamination over a period of time, that the contamination of milk is essentially proportional to the contamination of the diet, and that contamination of the diet is essentially proportional to the product of the rate of contamination and the time of exposure. Graphic presentations of the three model cases illustrate twelve successive conditions possible for each model case. (C.H.)

14116 MEASUREMENT OF ENVIRONMENTAL RADIOACTIVITY WITH BASIC COUNTING EQUIPMENT. Jacob Verduin (Bowling Green State Univ., Ohio). Ohio J. Sci., 61: No. 1, 6p.(Jan. 1961).

Instruments purchased with an educational grant from the AEC measured the radioactivity of ash from materials collected in nature. Ash from plant leaves showed levels of about 1000 $\mu\mu$c/g during 1957 and 1958. Leaves collected in 1959 showed levels only one-half so high. Ash from corn stalks was only one-third as radioactive as that from leaves. Surveys of this kind can be carried out by undergraduate students. (auth)

14117 THE DISTRIBUTION OF RADIOISOTOPES AMONG MARINE ORGANISMS IN THE WESTERN CENTRAL PACIFIC. Allyn H. Seymour (U. S. Atomic Energy Commission, Washington, D. C.). Pubbl. staz. zool. Napoli, 31: Suppl., 25-33(1959). (In English)

Specific isotopes are associated with particular organisms and tissues. Of the long-lived fission products—Sr^{90}, Cs^{137}, and Ce^{144}—only Ce^{144} is present in marine organisms in significant amounts. Of the induced radioisotopes, $Fe^{55, 59}$, Zn^{65}, $Co^{57, 58, 60}$, and Mn^{54} contribute up to 100 per cent of the radioactivity in marine animals but practically none of the radioactivity in marine algae. Oceanic fish differ from reef fish in that Zn^{65} ranks first with the ocean fish and Fe^{55} for the reef fish. Plankton in comparison with fish have greater amounts of Co^{60} and lesser amounts of Fe^{55}. The distribution of radioisotopes in terrestrial plants and animals from the same geographical area is greatly different than the distribution in marine organisms. (auth)

14118 RADIOBIOLOGICAL STUDIES AT THE ENIWETOK TEST SITE AND ADJACENT AREAS OF THE WESTERN PACIFIC. Lauren R. Donaldson (Univ. of Washington, Seattle). 7p. of "Transactions of the Second Seminar on Biological Problems in Water Pollution, April 20-24, 1959." Cincinnati, Robert A. Taft Sanitary Engineering Center, 1959.

The results of successive studies over a period of twelve years have shown that biological activity is often of greater importance than physical factors in the distribution and localization of radioactive products in a marine environment. Certain organisms, notably algal and planktonic forms, remove minerals from the water within hours. Much of the uptake is by absorption. The amount of uptake by invertebrates and fish is primarily dependent on feeding habit, indicating the importance of food chains in the distribution of radioactive materials. Biological effects directly attributable to the injurious effects of radioactive contamination have not been evident. Competition is so severe that any injured individuals are likely to be eliminated and replaced before they are observed. It is clear from the rapidity of uptake of radioisotopes that there is a great thirst for minerals by organisms in the marine environment. The practical implication, therefore, is that fertilization of specific areas with mineral products could overcome one of the limiting factors to biological productivity. Under some conditions suitable isotopes could be used as an index of the efficiency of such fertilization. (auth)

Radiation Effects on Living Tissues

14119 (ORO-373) DEVELOPMENTAL-GENETIC STUDY OF THE EFFECTS OF X-RAY IRRADIATION IN DROSOPHILA VIRILIS AND BUFO VALLICEPS. Final Scientific Report, January 1, 1955–December 31, 1960. Frances E. Clayton (Arkansas. Univ., Fayetteville. Coll. of Arts and Sciences). Mar. 1, 1961. Contract AT(40-1)-1974. 115p.

Normal spermatogenesis in Drosophila virilis was studied by examining living cells by phase-contrast microscopy. Primary spermatocytes were observed to occur in cysts of eight cells. Histological analysis of sections from adult males indicated a two-day cycle in meiosis until the males are sexually mature at six days. Following the sixth day the number of immature cells in the testes decreased steadily without further peaks in the number of primary spermatocytes on alternate days. Spermatozoa were not motile and functional until the sixth day. Typical configurations of chromosomes during spermatogenesis, in spermatogonia, spermatocytes, and very early spermatids are

presented. Results are included from a series of tests to determine the effects of irradiation on Drosophila virilis males as measured by dominant lethal and translocation rates in cells at various stages of spermatogenesis and sperm differentiation. Males at different ages were irradiated under similar conditions and mated with mature virgin females within one hour after irradiation and left for five days. After this preliminary period, during which no fertile eggs were deposited, the males were remated to mature virgin females and daily egg counts were made. After a two-day mating period, the males were remated and egg counts made. This procedure was continued for a total of eight consecutive mating periods. Data are tabulated on rates of dominant lethals resulting from irradiation during various stages of spermatogenesis. (C.H.)

14120 (TID-12349) THE EFFECTS OF IONIZING RADIATIONS ON GENE AND CHROMOSOME MUTATION RATES IN NORMAL HUMAN CELLS IN TISSUE CULTURE. H. Bentley Glass (Johns Hopkins Univ., Baltimore). Mar. 29, 1961. Contract AT(30-1)-1939. 11p.

A diploid cell line from the rat iris has been kept in culture for a period of 16 months without loss of its diploid genetic constitution. X-ray treatments of 24 r and 50 r have failed in preliminary tests to produce mutations at the ABO blood group locus, but the tests are not conclusive. Further experiments are planned using the ABO markers. Studies are in progress to compare the effects of x rays on chromosomes of Chinese hamster, monkey, and human cells in vivo and in vitro, with control of oxygen tension, pH, temperature, buffering, dose, and recovery rate. Corneal epithelium is the tissue of choice. The effects of various radiomimetic substances are being compared with the effects of ionizing radiation in respect to preferential as against random chromosome breakage. Identification of heterochromatic regions in human chromosomes seems possible. The actual initiation and rate of origin of polyploidy in human cells growing in culture is being charted. A cell strain highly resistant to streptomycin has been produced and will be used to test genetic transformation, by exposure to DNA, from streptomycin sensitivity to streptomycin resistance. In this experiment the highly efficient technique of screening for mutants by killing all non-transformed cells can be applied. Preliminary studies of enzyme deficiencies which may be used as genetic markers in cell cultures have been undertaken. The work with galactose-1-phosphate uridyl transferase is promising. Tissue culture studies of two hamster melanomas, one of melanotic, the other of amelanotic cells, have revealed a new giant type of cell that ingests and destroys melanocytes. Evidence has been found that serum from animals bearing melanomas will kill the melanoma cells growing in culture. (auth)

14121 (UCRL-9454) EXPERIMENTAL SETUP AND DOSIMETRY FOR INVESTIGATING BIOLOGICAL EFFECTS ON DENSELY IONIZING RADIATIONS. Tor Brustad, Piero Ariotti, and John Lyman (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 28, 1960. Contract W-7405-eng-48. 30p.

An experimental setup used for the study of the effects on various biological systems of densely ionizing radiations is described. Special emphasis is placed on the dosimetry. The Faraday cups, beam monitors, and ionization chambers are described. This equipment and the new bombardment chambers permit specimens to be irradiated under a greater variety of conditions than was possible previously. (auth)

14122 (WT-794) BACTERIOLOGICAL STUDIES ON ANIMALS EXPOSED TO NEUTRON RADIATION. Project 23.2 [of] OPERATION UPSHOT-KNOTHOLE. Myron S. Silverman and Victor P. Bond (Naval Radiological Defense Lab., San Francisco). July 1953. Decl. Oct. 12, 1960. 22p.

Mice exposed to supralethal doses of neutron radiation and combined neutron and gamma radiation from the nuclear device used in Upshot-Knothole 9 (May 8, 1953) died within 2.5 to 4 days. Bacteriological examination of the heart blood and spleen from animals sacrificed while moribund revealed that 78% of the animals receiving only neutron radiation and 96% receiving combined neutron and gamma radiation suffered an extensive invasion by the normal intestinal bacteria. Contrary to findings reported elsewhere on animals exposed to x rays, invasion by two or more species of bacteria was found to be a common occurrence. In a large number of animals examined, positive cultures were obtained only from the spleen. This is interpreted as indicating that, although the filtering mechanism of the spleen still functioned, this organ was unable to destroy the invading bacteria either because of the overwhelming number of bacteria or because of the injury to the spleen itself. Hence the organisms continued to multiply and eventually spilled back into the circulatory system. (auth)

14123 (AEC-tr-4531) EFFECTIVENESS OF THE BIOLOGICAL ACTION OF C^{14} WHEN INCLUDED IN LIVING STRUCTURES. A. M. Kuzin, B. M. Isaev (Isayev), V. V. Khvostova, V. I. Tokarskaya, and Yu. I. Bregadze (Akademiya Nauk S.S.S.R.). 1960. Translation of United Nations Report A/AC.82/G/L.423. 9p.

The biological effects of a two or three day exposure to beta particles from C^{14} were compared with the effects of a similar radiation dose from external Co^{60} gamma radiation. The percentage of cells of Vicia faba with chromosome aberrations at the growth points of the stem following exposure was used as a criterion for biological action. Data are tabulated. Analysis of results shows that the mutagenic effect of C^{14} introduced into the cells is 9 to 15 times greater than the effect of equal absorbed doses of outside gamma radiation. It is assumed that a significant part of the mutagenic effect of C^{14} depends on the conversion of C^{14} to N^{14}. The possible influence of radioactive carbon from the explosion of megaton hydrogen bombs on living organisms is discussed briefly. (C.H.)

14124 MOLECULAR RADIOBIOLOGY OF HUMAN CELL LINES. I. COMPARATIVE SENSITIVITY TO X-RAYS AND ULTRAVIOLET LIGHT OF CELLS CONTAINING HALOGEN-SUBSTITUTED DNA. R. L. Erikson and W. Szybalski (Univ. of Wisconsin, Madison). Biochem. Biophys. Research Communs., 4: 258-61(Mar. 24, 1961).

The incorporation of 5-halogenated thymidine analogs, 5-bromo- or 5-iododesoxyuridine into desoxyribonucleic acid of mammalian cells in tissue culture increased their sensitivity to ultraviolet light and also to x rays. Data are presented graphically and the molecular mechanism of the radiosensitizing effects of halogenated thymidine analogs is discussed. (C.H.)

14125 GENETIC TRANSFORMATION STUDIES. II. RADIATION SENSITIVITY OF HALOGEN LABELED DNA. Zofia Opara-Kubinska, Z. Lorkiewicz, and Waclaw Szybalski (Univ. of Wisconsin, Madison). Biochem. Biophys. Research Communs., 4: 288-91(Mar. 24, 1961).

The replacement of the methyl group in the 5-position of the thymine molecule by halogen atoms produces a biologically functional analog which can be substituted for thymine in the desoxyribonucleic acid molecule. Tests were made of the sensitivity of this labeled desoxyribonucleic acid to ultraviolet light and x radiation, and the results were compared to the sensitivity of intact cells. Results indicate

that desoxyribonucleic acid is the most radiosensitive cell component and thus the principal target of lethal radiation effects. (C.H.)

14126 LEUKEMIA AND LYMPHOMA MORTALITY IN RELATION TO COSMIC RADIATION. Leonard Craig and Herbert Seidman. Blood, 17: 319-27(Mar. 1961).

The 1949 to 1951 leukemia and lymphoma mortality rates for the 163 metropolitan areas in the United States were compared to the corresponding elevations of the areas, taken as an approximate measure of the intensity of cosmic radiation. No increase in mortality rates with rise in elevation was apparent. From this it is concluded that at usual habitation levels in the United States variation in cosmic ray intensity either has no effect upon leukemia and lymphoma mortality rates, or has very small effect as compared to other factors. The same procedure was applied to congenital malformation mortality rates. In this instance, there appears to be a distinct increase in this condition between the lowest elevation zone and all others. If positive relationship between the intensity of cosmic radiation and the rate of congenital malformations is assumed, it is reasonable to expect a progressive increase in congenital malformations as elevation, and hence cosmic radiation, increases. However, the rate of congenital malformation mortality remains fairly constant over the three highest elevation zones. From this it is concluded that the variation in the intensity of cosmic radiation does not play an important part in the mortality from this disease. It is possible that some factor not considered accounts for the difference in congenital malformation mortality between the lowest elevation zone and the other zones. (auth)

14127 HISTOLOGICAL AND DOSIMETRIC CONSIDERATIONS OF BONE TUMOUR PRODUCTION WITH RADIOACTIVE PHOSPHORUS. J. P. M. Bensted, N. M. Blackett, and L. F. Lamerton (Royal Cancer Hospital, London). Brit. J. Radiol., 34: 160-75(Mar. 1961).

A study is reported of the production of bone tumors in rats following internal administration of P^{32} as single and as repeated injections. An attempt has been made to relate the radiation dosage pattern in the bones, determined by thick section autoradiography, with the histological changes observed and the subsequent production of tumors. The possible significance of radiation-induced fibrosis in tumor production is discussed. (auth)

14128 SELECTIVE CHEMICAL PROTECTION OF THE INTESTINE IN THE MOUSE IRRADIATED WITH SUPERLETHAL DOSES OF X RAYS. Raymond Latarjet, Odette Lartigue, and Edith Estienne (Institut du Radium, [France]). Compt. rend., 252: 948-50(Feb. 6, 1961). (In French)

The mixture 2-aminoethylisothiorea–Thiogel, administered orally, protects selectively the intestine and permits the irradiation of the mouse with doses much higher than those for hemopoietic death without causing intestinal death. (tr-auth)

14129 CYTOCHEMICAL REACTIONS OF RIBONUCLEOPROTEIDS OF MITOCHONDRIA AND OF THE TIGROID BODY OF NERVE CELLS WITHIN THE FIRST MINUTES FOLLOWING γ-IRRADIATION. A. L. Shabadash, T. I. Zelikina, and N. D. Agracheva (Inst. of Biological Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 222-5(Jan. 1, 1961). (In Russian)

Experiments were carried out with 185 to 200-g male white rats exposed to 1000 r of γ radiation at 100 r/min. Early disturbances in nerve cells are expressed in a sharp shift of the isoelectric points of ribonucleoproteids (RNP) in the mitochondria and tigroid toward the alkali direction. Quantitative variations of isoelectric points in the mitochondria and tigroid of various neurons were studied at one-minute intervals, starting with the first hour. The data indicate the strongest isoelectric shift characterizes the afferent ganglion cell mitochondria. One minute after exposure the isoelectric shift reached 0.9 to 1.0 on the pH scale, in 5 min it increased 1.2 and in 10 min 1.4. After 12 min, the shift decreased, and after 17 min a drop was clearly observed (0.5). After 30 to 60 min the shift is only 0.8 to 0.6. Isoelectric point shifts in mitochondria and tigroid RNP in the spinal cord ganglia nerve cells, in spinal motor cells, and in the cells of the third and fourth layer of the sincipital cerebral cortex are plotted (in pH units) for various intervals following irradiation. The initial isoelectric point changes are interpreted as a form of protective mechanism against radiation injuries. (R.V.J.)

14130 EFFECT OF IONIZING RADIATION ON DEOXYRIBONUCLEIC ACID. III. THE STRUCTURE OF HIGHLY POLYMERIZED DEOXYRIBONUCLEIC ACID FROM IRRADIATED RAT SPLEEN. E. Palecek (Inst. of Biophysics, Academy of Sciences, Brno). Folia Biol. (Prague), 7: 61-5 (1961). (In English)

The structure of desoxyribonucleic acid (DNA) isolated by the Schmidt-Thannhauser method from the spleen of rats irradiated with a dose of 400 r was investigated. Five days after irradiation the guanine/cytosine quotient and the adenine/thymine quotient were approximately two and after 18 days were still higher than one. The two quotients did not again equal the values in nonirradiated animals until 30 days after irradiation. In DNA isolated in a highly polymerized form from the same sources, the guanine/cytosine quotient and the adenine/thymine quotient were also about equal to one five days after irradiation. The increase in the purine/pyrimidine quotient in DNA isolated by the Schmidt-Thannhauser method is attributed to the presence of products of the enzymatic hydrolysis of DNA. (auth)

14131 THE EFFECT OF X-RADIATION ON THE MOUSE RETINA AT DIFFERENT STAGES OF DEVELOPMENT. D. R. Lucas (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 3: 105-24(Mar. 1961). (In English)

The histological response of the mouse retina to x irradiation was studied in relation to post-natal development; it was measured by the relative numbers of nuclei surviving under different conditions of age and dose. The radiosensitivity of the undifferentiated retina was high; after 150 rads pyknosis soon developed in the formative nuclear zones. Cell-killing was not entirely due to an effect on mitosis because the cells killed in 6 hours outnumbered the mitoses accumulating 6 hours after colchicine. When the retinal layers had formed, their component cells were much less radiosensitive. At age 13 days a dose of 3800 rads halved the number of visual cells, but hardly affected the bipolar cells. Subsequently, the radiosensitivity of the visual cells increased (D50 at age 28 days: 1600 rads) and then decreased (D50 at age 3 months: 2700 rads). These alterations were related to cytological differentiation, not mitosis. (auth)

14132 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE GLUTATHIONE CONTENT OF RAT THYMUS. M. J. Ashwood-Smith (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 3: 125-32(Mar. 1961). (In English)

The reduced glutathione content of rat thymus was measured by amperometric titration. During the rapid growth of the rat the glutathione concentration remained

onstant. Whole-body x-irradiation with 200 rads and 900 rads caused a significant fall in glutathione concentration pparent after 110 min. The magnitude of this fall was ittle affected by increased doses of x radiation, and it is nlikely that a direct radiochemical reaction was the cause f the lowered glutathione levels. These results are dis-ussed with relation to the known sensitivity of thymus to x rays, and it is suggested that glutathione levels fall before istological evidence of death is forthcoming. The normal value for reduced glutathione per thymocyte was found to e 413×10^{-12} μ moles per cell. (auth)

14133 METABOLIC REPAIR OF PREMUTATIONAL DAMAGE IN PARAMECIUM. R. F. Kimball, Nenita Gaicher, and Stella W. Perdue (Oak Ridge National Lab., Tenn.). Intern. J. Radiation Biol., 3: 133-47(Mar. 1961). (In English)

The problems of experimental analysis of the post-irradiation processes leading to mutation are considered in some detail. In particular, methods for separating the effects of various modifiers on the rate of these processes from the effects on the time available for them to occur are discussed. Data are presented for recessive lethal mutations in Paramecium to show that all metabolic inhibitors tried (caffeine, iodoacetate, chloramphenicol, and streptomycin) decrease the rate of loss of premutational damage and decrease mutation only because they increase the time available for loss. The results are shown to fit the hypothesis of metabolic repair of radiation-induced lesions of the chromosomes. (auth)

14134 THE EFFECT OF BODY TEMPERATURE ON THE SENSITIVITY OF THE HAEMOPOIETIC TISSUES OF MICE TO X-IRRADIATION. L. Weiss (National Inst. for Medical Research, London). Intern. J. Radiation Biol., 3: 149-54(Mar. 1961). (In English)

The effect of x-irradiation on the hemopoietic tissues of mice while they are at body temperatures of 15°C is described. Histological examination of the spleen and femoral bone marrow revealed no differences between groups of animals irradiated at body temperatures of 15°C and those irradiated at normal body temperatures and then cooled to 15°C over the dose range 0 to 950 r. The total peripheral-leukocyte counts were compared with those obtained in previous experiments when animals were irradiated at body temperatures of 1°C and at normal body temperatures. Statistical analysis shows that on the evidence of leukocyte counts five days after irradiation, exposure of animals to x rays while they are at body temperatures of 15°C affords slight protection to the hemopoietic tissues, which is much less than the protection provided at body temperatures of 1°C when the animals are severely hypoxic. Cooling to 15°C after irradiation affords no detected radioprotection. (auth)

14135 RADIOSENSITIVITY AND METABOLIC PROPERTIES OF TWO TUMOUR-TYPES INDIGENOUS TO THE SAME HOST. I. A CORRELATION OF CELLULAR STRUCTURE AND RADIOSENSITIVITY. Anna Goldfeder (Cancer Research Lab., New York and New York Univ., New York). Intern. J. Radiation Biol., 3: 155-72(Mar. 1961). (In English)

The radiosensitivity and metabolic properties of two types of mouse mammary tumors, epithelial (DBAH) and spindle (DBAG), both indigenous to the same host, are under extensive study. The cytological response of these tumors to 500, 1000, and 3000 r is described. The spindle-tumor cells (DBAG) proved to be more radiosensitive and produced unusually abnormal mitotic figures, unipolar and multipolar. Electromicrographs of this tumor revealed a paucity of mitochondria and their inferior quality, thereby explaining their extremely low capacity to phosphorylate in comparison with the epithelial tumor (DBAH). It is postulated that the quantity and quality of mitochondria play a significant role in cellular radiosensitivity. Thus the chromosomal imbalance may not be the only factor in cell-death induced by irradiation. This postulate is supported by observations on the tumors. (auth)

14136 ANALYSES OF THE DIFFERENTIAL RADIOSENSITIVITY OF DEVELOPING REPRODUCTIVE TISSUES IN HABROBRACON JUGLANDIS (ASHMEAD) TO IONIZING RADIATION. Howard E. Erdman (General Electric Co., Richland, Wash.). Intern. J. Radiation Biol., 3: 183-204 (Mar. 1961). (In English)

Significant developmental stages throughout the life cycle of the holometabolous and ectoparasitic insect, Habrobracon juglandis (Ashmead) were x rayed with 300 r increments until sterility was illustrated by adult performance. Because of parthenogenetic male production, attention was focused on females. Cytological examination of ovarioles from adults x rayed at the different stages gave rise to three conclusions concerning the radiopathology of the reproductive system. Regardless of dose, somatic tissues functioned normally to produce four ovariole sheaths. Radiation of larvae adversely affected the trophocytes rather than the oocyte itself, apparently the damage is chromosomal. Radiation of pupae interfered with egg-nurse syncytia differentiation from oogonia. (auth)

14137 CONTRIBUTIONS TO THE STUDY OF IMMEDIATE AND EARLY X-RAY REACTIONS WITH REGARD TO CHEMOPROTECTION. I. FURTHER ANALYSIS OF THE IMMEDIATE DROP IN INJECTION PRESSURE ON MODERATE IRRADIATION. R. Brinkman, H. B. Lamberts, J. Wadel, and J. Zuideveld (Univ. of Groningen, Netherlands and Promonta A. G., Hamburg). Intern J. Radiation Biol., 3: 205-10(Mar. 1961). (In English)

The immediate x-ray depolymerization of the mucopolysaccharide matrix in the dermal layer of the skin, the cock's comb, the aortic wall, and in thin membranes is demonstrated, and in the skin it is further analyzed. Irradiation is with low doses, and measurements are made of injection pressure and of filtration rate. (auth)

14138 EFFECT OF IONIZING RADIATION ON BACTERIA. A Literature Review. M. Worseck (Veterinärunterschungs- und Tiergesundheitsamt, Potsdam, Ger.). Isotopentechnik, 1: 77-82(Jan. 1961). (In German)

As a basis for the explanation of the effects of ionizing radiation on bacteria, water radiolysis is discussed, since the bacterium cell is 85 to 90% water. First of all, H-atoms and OH-radicals are formed. The inactivation consists of the direct target theory and the indirect action of the modified water and cell molecules. As an e-function in semilogarithmic representation, the curve is frequently a straight line, but it may also take sigmoidal shapes. The dependence on outside influences such as initial concentration of bacteria, time, dosage, age medium, or nutritive substrate is discussed. Among the vegetative microorganisms, the gram-negative ones are the most sensitive, then follow the gram-positive, whereas the spores are considerably more resistant to radiation. In conclusion, a brief outlook on practical applications in radiation sterilization is given. (auth)

14139 RESISTANCE TO X-IRRADIATION BY EMBRYONIC CELLS OF THE LIMB-BUDS OF TADPOLES. Bennet M. Allen and Leroy M. Ewell (Univ. of California, Los Angeles). J. Exptl. Zool., 142: 309-35(1959). (UCLA-450)

Both total-body irradiation and shielding of the trunk

were used to study the effects of x irradiation from 1000 to 30000 r upon the limb-buds of Bufo boreas and Hyla regilla tadpoles. The object was to test the view that the younger the cells the more sensitive they are to irradiation. The answer is negative. If there is any special susceptibility of these undifferentiated cells it should appear at levels far below the 30000 r maximum employed. A sharp distinction is made between the very susceptible mitotic cells and the resistant non-dividing embryonic cells that have been accumulated in such numbers that they may rapidly differentiate into the characteristic limb tissues under the stimulus of the thyroid hormone. Many irradiated ectoderm cells were changed to form bizarre excrescences but were not destroyed. Unicellular cutaneous gland cells continued to arise even after the heaviest irradiation. Irradiated tadpoles with hind limb-buds from 0.6 mm down to 0.2 mm length were unable to develop normal limbs. This capacity was proportional to the number of non-dividing embryonic cells stored at the time of irradiation. Irradiation of 5000, 10000, 20000, and 30000 r destroyed the mitotic cells in equal degree but the rapidity was greatest in the cases of higher dosage. Not only did these levels of irradiation fail to destroy the non-dividing embryonic cells but they did not effect their pre-determined specificity nor modify their capacity for subsequent differentiation and growth. Exposure to a thyroxin solution caused the hind limb-buds without visible differentiation of cells to grow from a length of 0.8 or 0.9 mm or 1.0 mm at the time of irradiation to a length of as much as 5.0 mm in the course of 7 days. Development of thigh, shank, ankle, and toes was complete. Microscopic studies showed characteristic tissues such as cartilage, connective tissue, and muscle, developed to a comparable degree in control and irradiated specimens. (auth)

14140 HISTOLOGICAL AND HISTOCHEMICAL RESEARCHES ON THE HEPATIC AND PANCREATIC TISSUES IN ANIMALS TREATED WITH ROENTGEN RAYS. M. Trasino, N. Macarini, and E. Gandolfo (Università, Genoa). Minerva fisioterap., 4: 15p.(1959). (In Italian)

The histological and histochemical changes induced in the liver and pancreas by experimental roentgen irradiation were studied. Four groups of animals were examined. Each animal received a variable dose of x rays (variable doses and variable numbers of administrations) on the abdomen. From the morphological standpoint it was observed that the hepatic and pancreatic lesions due to irradiation consists essentially in cloudy-vacuolar degenerative processes. Histochemical tests for enzymatic activities constantly revealed inhibition of ADN, whereas no marked variations of ARN occurred. The hypothesis is suggested that the hepatic and pancreatic changes are closely related with impairment of the nucleic acid metabolism. (auth)

14141 COMPARATIVE HISTOLOGIC AND HISTOCHEMICAL STUDIES ON THE INTESTINAL, HEPATIC AND PANCREATIC CHANGES INDUCED BY ANTIMITOTIC DRUGS AND X RAYS. M. Trasino and E. Gandolfo (Università, Genoa). Minerva fisioterap., 5: 20p.(1960). (In Italian)

A comparative study was made of the intestinal, hepatic, and pancreatic changes induced in experimental animals by antimitotic drugs and x rays. Two groups of guinea pigs were used. The first group was treated with desacetyl-methyl-colchicine; the second with methyl-trisamine chloride. Histologic and histochemical tests on sections of these organs revealed a considerable similarity between the changes induced by antimitotic drugs and those caused by roentgen irradiation. This finding was interpreted as a confirmation of the importance of the disappearance or diminution of cellular renewal in the pathogenesis of the hepatic, intestinal, and pancreatic changes due to x rays. (auth)

14142 MULTI-STRANDED DEOXYRIBONUCLEIC ACID AS DETERMINED BY X-IRRADIATION. Liebe F. Cavalieri, Roland Finston, and Barbara Hatch Rosenberg (Cornell Univ. Ithaca, N. Y.). Nature, 189: 833-4(Mar. 11, 1961).

The decay in molecular weight induced by irradiation of desoxyribonucleic acid (DNA) from calf thymus, sea urchin sperm, and Pneumococcus was examined as a function of x-ray dose. Molecular weights were determined by light scattering. Results support conclusions that DNA molecules from non-proliferating sources are double helices, whereas molecules from proliferating sources consist of linked pairs of double helices. (C.H.)

14143 A NEW EFFECT OF IONIZING RADIATION ON NUCLEOPROTEIN. G. Hems (Royal Cancer Hospital, London). Nature, 189: 849-51(Mar. 11, 1961).

An aqueous solution of nucleoprotein prepared from calf thymus was irradiated with high-energy electrons to a dose of 4×10^6 rads. Immediately following irradiation a white suspension collected at the bottom of the container. When irradiated and control solutions were analyzed, it was found that in addition to producing a precipitate, irradiation had degraded the amino acids, purine and pyrimidine bases, and desoxyribose sugar. Analysis of the precipitate showed the presence of an acidic protein with purine and pyrimidine bases attached. The production of this precipitate by ionizing radiation confirms the presence of an acidic protein in the structure of nucleoprotein. The possible role of this precipitate in the biological effects of ionizing radiation is discussed. (C.H.)

14144 ELECTROPHORETIC PATTERNS OF LYMPH NODE PROTEINS IN HYBRID F_1 MICE IRRADIATED AND TREATED WITH MYELOID AND LYMPHOID CELLS FROM A PARENTAL STRAIN. V. Schwarzmann, G. Mathe, and J. L. Amiel (Hospital Saint-Louis, Paris). Nature, 189: 1025-6(Mar. 25, 1961).

An investigation, by starch gel electrophoresis, was made of the effects of graft immunization in lymph nodes on the electrophoretic pattern of the lymph node proteins from irradiated mice. It is implied that eventual modifications in patterns could correspond to the graft antibody located inside the immunized cells. Results led to the conclusion that the bond shown in starch gel whenever an immunity reaction takes place in the lymph nodes may correspond to the production of the antibody. (C.H.)

14145 THE REACTION OF THE HAEMOPOIETIC SYSTEM DURING RADIOTHERAPY OF MALIGNANT DISEASE OF THE FEMALE GENITAL TRACT. A. A. Gabelov (Sanitary Hygiene Medical Inst., Leningrad). Problems Oncol. (U.S.S.R.) (English Translation, 6: 1325-33(1960).

The reaction of the hemopoietic system of irradiated patients varies with the method used for combined irradiation therapy, with a dose applied to the primary lesion and with the time over which the dose applied is spread. The most damaging method is undoubtedly the simultaneous use of radioactive cobalt along with deep x ray therapy given in the interval between the cobalt applications. The first signs of damage to hemopoiesis are noted when a dose of 3000 to 4000 r has been given to the region of the primary lesion (gamma irradiation) and 4000 to 5000 r in total to the skin during deep x ray therapy. The least damaging method was divided fractional irradiation with radioactive

cobalt preparations followed by deep x ray therapy. In such cases the bone marrow changes were less pronounced and occurred much later, namely on attaining a dose of 6000 to 8000 r in the region of the primary lesion (gamma irradiation) and 8000 to 10000 r to the skin in the case of x ray therapy. The most characteristic disturbances in the hemopoietic system are described. The changes observed in the hemopoietic system of patients undergoing irradiation therapy are reversible if energetic use is made of hemostimulatory agents. (auth)

14146 THE BLOOD PICTURE DURING IRRADIATION THERAPY OF MALIGNANT DISEASE OF THE FEMALE GENITAL TRACT. I. K. Ryvkis (Medical Inst., Rostov-on-Don, USSR). Problems Oncol. (U.S.S.R.) (English Translation), 6: 1333-6(1960).

Investigations show that changes in the blood picture occur in practically all cases during deep radiotherapy. The changes are limited to the white cells in the form of lymphopenia, leukopenia, and eosinophilia. In the case of telegamma therapy the earliest change was lymphopenia, to which leukopenia was subsequently superadded in half the cases. Parallel with lymphopenia and leukopenia there was also development of eosinophilia during radiotherapy; its degree paralleled that of the lympho- and leukopenia. The blood changes developing during deep radiotherapy set in after 4000 to 4500 r had been given and their onset was earlier in proportion as the preceding operation had been the more traumatizing. Blood transfusion during radiotherapy arrested further progression of lympho- and leukopenia, and sometimes induced improvement, especially when concentrated leukocytes suspension was administered. Prophylactic transfusion is recommended, particularly concentrated leukocytes suspension, once every 7 days. (auth)

14147 LETHALITY OF UPPER BODY EXPOSURE TO X-RADIATION IN BEAGLES. Carl L. Hansen, Jr. (Office of the Surgeon General, Washington, D. C.), Sol M. Michaelson, and Joe W. Howland. Public Health Repts. (U.S.), 76: 242-6(Mar. 1961).

In experiments with beagles, the LD-50/30 for animals with whole-body exposure to 1,000 kvp x rays is placed at 250 r. The LD-50/30 for upper body exposure to 1,000 kvp x rays is placed at 1,775 r. The gram-roentgen dose required to produce a median lethal dose is raised fourfold by the shielding of the lower portion of the body. (auth)

14148 FETAL TOLERANCE TO RADIATION. Alvaro Ronderros (Medical Coll. of Alabama, Birmingham). Radiology, 76: 454-6(Mar. 1961).

A forty-year-old female received therapeutic radiation during her eleventh pregnancy, for carcinoma of the cervix. A calculated x ray dose of 754 r in two weeks, plus 134 r from the radium source, was given to the center of the gravid uterus during the sixth month of fetal age. A premature male infant was delivered by induced labor. This child, now eleven years of age, shows no evidence of physical or mental abnormality. (auth)

14149 INVESTIGATIONS ON THE MECHANISM OF BIOLOGICAL ACTION OF IONIZING RADIATIONS AND RADIOMETRIC DRUGS. Franco Pozza (Universita, Padua). Ricerca sci., 30: 2111-13(Dec. 1960). (In Italian)

A series of investigations is made in an attempt to get a thorough knowledge of the mechanism of biological action of ionizing radiations and radiomimetic drugs. Experiments are carried out following two courses: study of the relationship in terminal effects produced by the two agents on hepatic cell metabolism, and investigations of common retarding effects which many compounds can exert on ionizing radiations and radiomimetic drugs. (auth)

14150 IONIZING RADIATION ACTION ON THE CORNEA. G. G. Kanbay. Vestnik Oftal'mol., No. 5, 16-17(Sept.-Oct. 1960).

The sensitivity of the normal cornea which has been subjected to a single dose of x radiation was studied in healthy rabbits. Results show that the early reaction of the cornea to penetrating radiation is a change in its tactile sensitivity. A definite latent period is evident, and this period is shortened from 4 to 3 weeks as the radiation dose is increased from 450 to 600 r. Irradiation by sublethal doses further shorten the latent period, therefore, a decrease in sensitivity depends on the dose. The greater the dose, the sooner the decrease in sensitivity occurs; the smaller the dose, the sooner does restoration set in. Not all the points on the surface of the cornea are identical in sensitivity. The pupil area is more sensitive than the periphery, and the points along the vertical meridian are less sensitive than the points along the horizontal. Changes in the indexes of tactile and pain sensitivity of the cornea indicate a certain degree of corneal cell perception of radiation action. The action of ionizing radiation on the cornea with its inherent sensitivity indicates a special reactivity which is brought about by the nervous system, and by biochemical and metabolic processes. (TCO)

14151 ON THE PROBLEM OF THE EFFECT OF FEEDING IRON-SACCHARATE ON THE X-RAY INDUCED MUTATION RATE IN DROSOPHILA MELANOGASTER. H. Traut (Kernforschungszentrum, Karlsruhe, Ger.). Z. Vererbungslehre, 91: 325-32(1960). (KFK-42) (In German)

The increase in x-ray induced rate of recessive sex-linked lethals in Drosophila melanogaster by feeding iron-saccharate, reported previously, has led to some far reaching conclusions about the participation of indirect mechanisms in the radiation induced mutation process. However, in large scale experiments the effect was not reproduced. Some of the tests represented an exact repetition of the former genetical and radiation procedures, in others further parameters (translocations, state of maturity of the irradiated germ cells, feeding of ferrous-gluconate) were considered. A certain factor of the genetical technique, representing a neglect of the dependence of the mutation rate on the state of maturity of the irradiated germ cells, is experimentally shown to be the probable cause of that discrepancy. Consequently, the speculations based on the earlier results seem to require reconsideration. (auth)

Radiation Sickness

14152 TREATMENT OF SECONDARY DISEASE IN RADIATION CHIMAERAS. D. W. van Bekkum and O. Vos (National Defence Research Organization T.N.O., Rijswijk, Netherlands). Intern. J. Radiation Biol., 3: 173-81(Mar. 1961). (In English)

The influence of addition of cereals and aureomycin to the diet and of injections of vitamin B_{12} on diarrhea and delayed death of radiation chimeras (mice treated with rat bone marrow) was investigated. It was found that aureomycin markedly suppressed diarrhea and mortality in C57BL and F_1 (CBA × C57BL) mice and that cereals had the same effect in CBA mice. Aureomycin was less effective in CBA mice and cereals were less effective in C57BL and F_1 hybrid mice. In a number of experimental groups the distribution of true chimeras, partial and total reversals, was recorded. The beneficial effects of aureomycin and the

supplement of cereals are not mediated by the induction of reversals. (auth)

14153 RESTORATION OF SERUM BACTERICIDAL ACTIVITY AND PREVENTION OF ITS LOSS IN X-IRRADIATED MICE. Lottie Kornfeld and C. Phillip Miller (Univ. of Chicago). J. Immunol., 86: 215-19(Feb. 1961).

The loss of normal serum bactericidal activity of CF-1 mice for a strain of Escherichia coli which occurs 12 hr after total-body x irradiation (600 r) was prevented if yeast autolysate, yeast ribonucleic acid, homogenates of normal mouse spleens, or bacterial endotoxin were injected 0.5 hr before or 0.5 hr after exposure to x rays. Injection 18 hr before irradiation was without effect. Injection of any of these substances during the postirradiation period, when bactericidal activity was absent, resulted in the appearance of bactericidins 18 hr after treatment. Spleens removed from donor mice 1 or more hr after exposure to 600 r failed to restore bactericidins in irradiated recipients. (auth)

14154 ACUTE RADIATION DEATH RESULTING FROM AN ACCIDENTAL NUCLEAR CRITICAL EXCURSION. J. Occupational Med., 3: Spec. Suppl., (Mar. 1961). p.146-92.

An accidental critical excursion took place in the plutonium recovery plant of the Los Alamos Scientific Laboratory on Dec. 30, 1958. The average whole-body dose in the lethal case was estimated at between 3900 and 4900 rads, with the incident dose to the upper abdomen calculated to be approximately 12000 rads of neutrons plus gamma radiation. Two other workers received total doses of approximately 130 and 35 rads, respectively, most of which was gamma radiation. The critical excursion took place in a tank of solution from which plutonium was being recovered, and the number of fissions was calculated to be $\sim 1.5 \times 10^{17}$. The accident and subsequent events are recounted. The clinical case of the fatality is reviewed in detail. Data are included from routine chemical and pathological studies and special biochemical studies, whole-body counts, and gamma spectral measurements, dosimetric calculations, and health physics studies of area radiation levels. It was clearly apparent that the radiation dose varied widely in different parts of the body and even in different parts of the same organ. Results of clinical studies, covering the 14 months following the accident, are presented for the two workers who were exposed to non-lethal doses. Analysis of blood data led to the conclusion that changes following exposures in excess of 100 rads are characteristic and of clinical significance, whereas doses below 50 rads produce blood changes which are too slight to be of any diagnostic value. 58 references. (C.H.)

14155 'NITRIC OXIDE—AND OXYGEN EFFECT' IN X-IRRADIATED SHIGELLA FLEXNERI. W. M. Dale, J. V. Davies, and C. Russell (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 189: 851(Mar. 11, 1961).

Results of studies on the effects of nitric oxide on the radiosensitivity of Shigella flexneri led to the conclusion that the effect produced is due largely to some latent, irreversible injury to unknown constituents of the cells with which nitric oxide may combine. This injury is revealed on subsequent irradiation. The nitric oxide effect is thus different from the oxygen effect, which is only seen when irradiation occurs in the presence of the gas. The effect of time of contact with, and of the concentration of nitric oxide during pre-treatment does not support the equivalence of nitric oxide and oxygen in their role in enhancing injury by radiation. (C.H.)

14156 EFFECT OF pH ON THE SENSITIVENESS OF TRYPSIN TO IONIZING RADIATION. J. A. V. Butler and A. B. Robins (Royal Cancer Hospital, London). Nature, 189: 852-3(Mar. 11, 1961).

The presence of air, as compared with vacuum, was found to diminish the radiosensitivity of dilute aqueous solutions of trypsin by a factor of about 3. The effect of varying the pH of the solution in which the trypsin was dissolved was investigated. The effect of oxygen on radiosensitivity was found to be dependent on pH. Typical in activation doses of 220-kv x rays are tabulated. Reaction mechanisms involved are discussed. (C.H.)

14157 BICILLIN IN DIFFERENT VARIANTS OF COMPLEX THERAPY AND PROPHYLAXIS OF ACUTE RADIATION SICKNESS IN DOGS. N. V. Rayeva and I. N. Usacheva. Patol. Fiziol. i Ekspti'. Terap., 4: No. 4, 74 (July-Aug. 1960).

Bicillin was tested on dogs subjected to 600 r of external x radiation and 350, 400, and 600 r of γ radiation. The preparation was administered on a background of complex therapy (8 dogs), in combination with streptomycin and chlortetracycline for therapeutic purposes (12 dogs), and in combination with streptomycin and chlortetracycline for therapeutic and prophylactic purposes (24 dogs). Bicillin was administered to the animals for therapeutic purposes in doses of 600000 active units once every 5 days, beginning with the first and through the 20th day; streptomycin was intramuscularly administered during the intervals daily in doses of 300000 active units two times per day, beginning with the second days, or in doses of 250000 active units two times daily, beginning with the 6th and through the 19th day. The complex of therapy consisted of a 40% solution of glucose, 5% solution of ascorbic acid, blood transfusion, vitamins, and supplementary nutrition. Bicillin was administered to the animals for therapeutic-prophylactic purposes in doses of 500000 active units 24 hr before irradiation and then once every 5 days through the 20th day. Streptomycin, simultaneously with bicillin, was administered internally in doses of 300000 active units twice daily, beginning with the first and through the 20th day. All the control dogs died within 10 to 13 days. Two of the dogs used for therapeutic experiments survived: one after the therapeutic application of bicillin with streptomycin, and the other following the administration of drugs for therapeutic-prophylactic purposes. The remainder of the dogs died after an average longevity of 14 to 18 days. This slight positive effect was ascribed to the simultaneous administration of bicillin and streptomycin. (TCO)

14158 THE STUDY OF THE ROLE OF SEROTONIN (5-HYDROXYTRYPTAMINE) IN THE PATHOGENESIS OF ACUTE RADIATION SICKNESS. II. CHANGES IN THE SEROTONIN CONTENT IN THE INTESTINE AND BRAIN IN ACUTE RADIATION SICKNESS. G. A. Chernov and M. O. Raushenbakh (Lenin Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation), 5: 577-82(1960).

Measurements were made of the serotonin content of tissues from the small intestine and brain of guinea pigs and rats following whole-body exposure to doses of x radiation ranging from 500 to 700 r. A possible connection between the changes in serotonin levels in blood and tissues was studied by parallel investigations of the serotonin level in whole blood from the same animals. Data are tabulated. The changes in serotonin levels in the intestine, brain, and blood were found to be different in rats

and guinea pigs. The changes in both were regarded as non-specific disturbances of the shock type. Possible reaction mechanisms involved are discussed. (C.H.)

14159 THE STUDY OF THE CLOTTING SYSTEM OF THE BLOOD IN ACUTE RADIATION SICKNESS. N. Ya. (Ia.) Lagutina (Lenin Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation), 5: 583-7(1960).

The effects of whole-body x ray doses of 600 r on the clotting system of the blood in dogs were studied. Measurements were made on the formation of thromboplastin, prothrombin, and fibrinogen, and the anti-coagulant activity of the blood. Free heparin was increased in 12 of 20 dogs exposed to LD_{85} doses of radiation. Thromboplastin formation was severely disturbed in all exposed animals. The effects of disturbances of the clotting process on the development of hemorrhages in the radiation syndrome are discussed. (C.H.)

14160 CHANGES IN SOME PROPERTIES OF FIBRINOGEN IN RADIATION SICKNESS. K. V. Gordeeva, K. S. Kosiakov, L. M. Pavlova, and L. V. Popel (Lenin Military Academy, USSR). Problems of Hematol. Blood Transfusion (U.S.S.R.) (English Translation), 5: 588-92(1960).

An investigation was made of some of the properties of fibrinogen isolated from the blood of dogs before and after irradiation. Qualitative changes were found in the irradiated fibrinogen which resulted in the loss of ability to clot at the normal rate and an altered rate of clot retraction. It is pointed out that in radiation sickness changes take place in the properties of fibrinogen and also in the fibrin formed. (C.H.)

14161 THE USE OF POLYGLUCIN IN THE STUDY OF THE VASCULAR PERMEABILITY IN DOGS WITH ACUTE RADIATION SICKNESS. R. V. Lenskaya (Lenskaia) and T. V. Polushina (Lenin Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation), 5: 643-7(1960).

Repeated intravenous injections of polyglucin were used to demonstrate disturbances of vascular permeability in dogs with radiation sickness. Results were compared with those from studies in which chromium chloride, labeled with Cr^{51}, was used as a tracer. It was demonstrated that radiation sickness is accompanied by an increase in vascular permeability from the second day after irradiation. (C.H.)

14162 RADIOPROTECTION BY MITOTIC INHIBITORS AND MERCAPTOETHYLAMINE. William E. Rothe and Marie M. Grenan (Walter Reed Army Inst. of Research, Washington, D. C.). Science, 133: 888(Mar. 24, 1961).

In the mouse, chemical interference with cellular proliferation alters the radiosensitivity of the bone marrow, resulting in protection from otherwise lethal x irradiation. When intestinal damage is minimized by appropriate timing and dosage, many mitotic inhibitors increase radioresistance and enhance the protective effects of mercaptoethylamine. (auth)

General and Miscellaneous

14163 (AFOSR-410) VIBRATIONAL RELAXATION IN CARBON DIOXIDE. W. J. Witteman (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jan. 1961. Contract AF49(638)-401. 38p. (BN-226)

The vibrational excitation of a CO_2 molecule in collision with another CO_2 molecule was investigated. A derivation of the cross section by means of the method of the distorted waves and the rate of total energy transfer are presented. It was concluded that there are two relaxation processes with different relaxation times related to direct excitation of the bending mode and excitation in series of the valence mode. Experimental results confirm this conclusion. The experimental relaxation time for the bending vibration was one-half of the calculated value, which may be considered a fair agreement in view of the uncertainty involved in the interaction potential and of other approximations which had to be introduced into the calculations. (auth)

14164 (ARL-TR-60-334) AN EXPERIMENTAL INVESTIGATION ON THE CHEMISTRY AND INTERCONVERSION OF BORON HYDRIDES. Riley Schaeffer (Indiana. Univ., Bloomington). Nov. 1960. Contract AF33(616)-5827. 28p.

A modification of the method of Shapiro for the preparation of diborane was developed which gives nearly quantitative yields of essentially pure diborane. Experimental studies of steps in the thermal conversion of diborane to pentaborane-11 were continued. The isotope effect in the decomposition of diborane suggested that the hydrogen is eliminated in the initial rate limiting step. An analysis of the subsequent fate of the triborane-7 molecule supported the belief that tetraborane-10 is next formed. Study of the conversion of tetraborane-10 to pentaborane-11 previously suggested the importance of the tetraborane-8 molecule. Support was offered for this interpretation by study of the decomposition of tetraborane-10 in the presence of carbon monoxide. Preliminary studies of the reaction of diborane with lithium amalgam are also reported. (auth)

14165 (DP-554) OXIDATION OF URANIUM(IV) BY OXYGEN AND NITROUS ACID. A. Laird Slade (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1961. Contract AT(07-2)-1. 12p.

The oxidation of uranium(IV) by oxygen and nitrous acid was studied in both 30% TBP—"Ultrasene" and in aqueous solutions. Emphasis was placed on reactions between uranium(IV) and nitrous acid. Distribution coefficients were measured for uranium(IV) and uranium(VI) in the nitric acid—30% TBP system. The use of uranium(IV) as a reductant for plutonium in the Purex process is discussed. (auth)

14166 (HW-61843) SPECIFIC GRAVITY OF ALUMINUM NITRATE SOLUTIONS. A. H. Case and C. W. Pollock (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 2, 1959. Contract AT(45-1)-1350. 3p.

Determination of specific gravity can be used as a means of estimating the concentrations of such solutions. However, when an aluminum nitrate solution is prepared by dissolving aluminum hydrate in nitric acid, a positive or negative nitric acid concentration must be considered and a relation connecting the three variables must be provided. The relations % ANN = $-130.069 + (143.601 \times$ sp. gr. 25°/4°) $- (1.487 \times$ % HNO_3) and mols al = $-7.34472 - 0.251751 \times HNO_3$ molarity $+ 7.13920 \times$ sp. gr. 25°/4° were found to serve for estimating aluminum nitrate nonohydrate (ANN) or aluminum concentration from specific gravity and nitric acid concentration. They apply in the range of 64 to 76.5% ANN with nitric acid varying from −1.99% to 0.89% or the range of 2.32 to 2.89 molar aluminum with −0.45 to 0.20 molar nitric acid. (auth)

14167 (NP-9936) UPGRADING OF STOCKPILED FUSED VANADIUM OXIDE (BLACK CAKE). C. J. Chindgren, L. C. Bauerle, and J. B. Rosenbaum (Bureau of Mines. Salt Lake City Metallurgy Research Center). Mar. 1961. 12p. (RR-56.1)

Procedures were investigated for upgrading vanadium black cake of nominal 86% V_2O_5 grade. The objective of the research was to delineate and compare alternative methods for converting the high-alkali black cake to a product of minimum 98% V_2O_5 grade. Procedures that were investigated included metathesis of black cake in natural, acid, and alkaline solutions of ammonium chloride to form ammonium vanadate, and dissolution of black cake in soda ash solution and subsequent precipitation of ammonium vanadate by addition of ammonium chloride to the soda ash leach liquor. The ammonium vanadate-type material made by the alternative procedures was decomposed to the oxide by heating at 450°C. The simplest procedure, metathesis in ammonium chloride solution, yielded 99% recovery of V_2O_5 in a product that contained about 4% total impurities, principally sodium, potassium, molybdenum, and manganese. A modification of this procedure that involved acidifying the solution to a pH of about 2 resulted in 98% recovery in a product that contained about 2% total impurities. Another modification, comprising addition of ammonia to the chloride solution, also yielded a product containing 2% total impurities, but the potassium content was higher and the molybdenum content lower than that obtained by treatment with acid solution. Vanadium recovery resulting from the use of ammoniacal solution exceeded 99%. The soda ash dissolution method corresponding to industrial practice for preparation of pure vanadium oxide resulted in over 99% vanadium recovery at 99+% V_2O_5 grade. Reagent requirements ranged from 2.5 pounds ammonium chloride per pound of black cake by metathesis in acid solution to 0.5 pound ammonium chloride and 0.2 pound ammonia when reacting in ammoniacal solution. The latter method, although economical with regard to reagents, required use of a close reaction vessel. The soda ash dissolution procedure was intermediate in reagent cost but embraced more process steps than the other procedures. (auth)

14168 (PAN-183/XVI) ESTIMATION OF THE RATE OF MATERIAL TRANSPORT IN ROTARY KILNS USED FOR DECOMPOSITION OF CALCIUM SULFATE AT THE SULFURIC ACID PLANT AT WIZOW, POLAND. K. Akerman, P. M. Hoffmann, A. Poczynajło, J. Majchrowski, J. Glondal-

ski, and J. Ogłaza (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Oct. 1960. 7p.

A radiometric study was made of the material transport rate in a rotary kiln used for the production of sulfur dioxide and cement clinker. Sodium metasilicate containing Na^{24} was chosen to label a dry charge. The experimental results obtained permit safer cementation of the wear lining of the kiln without stopping it and suggest construction improvements of the kilns as well as their production technology. (auth)

14169 (TID-11068) POLAROGRAPHIC BEHAVIOR OF ORGANIC COMPOUNDS. Technical Progress Report for the Period November 1, 1959 to October 1, 1960. (Michigan. Univ., Ann Arbor). 15p. Contract AT(11-1)-70, Project 8.

Theoretical and experimental investigations were made of electrode processes and their application to analytical and other chemical problems. Studies were completed on the kinetics and mechanisms of two of the four types of organic systems started last year: nitro and carbonyl group reductions. The comprehensive investigation of stereochemical factors in the electrochemical behavior of the C_4 dibasic acids and their esters was completed. Other areas which have yielded interesting information include further investigation of the reduction of carbon-halogen bonds and the correlation of structure with electrochemical behavior. (W.L.H.)

14170 (TID-11865) CARBON-14 ISOTOPE EFFECTS IN THE DECARBOXYLATION OF 2-BENZOYLPROPIONIC ACID. Ernest M. Hodnett and Richard L. Rowton (Oklahoma State Univ., Stillwater). [1960?]. 18p. (RICC/170)

An investigation was made to determine the C^{14} kinetic isotope effects associated with the decomposition of a β-keto acid labeled successively in the 1,2 and carbonyl positions. 2-Benzoylpropionic acid was selected for this work because it decomposes cleanly at relatively low temperatures and is sufficiently stable at room temperature. The isotope effects were determined by radioassay of the acid both before and after a known amount of reaction occurred. The extent of the reaction was determined by the volume of carbon dioxide liberated. The isotope effect ranged from 1.000 to 1.077. Results of the C^{14} isotope effects did not show any correlations with a cyclic transition state in the concerted reaction. (M.C.G.)

14171 (TID-11886) A STUDY OF THE MECHANISM OF INTERFACIAL POLYAMIDATION AND POLYESTERIFICATION. Ernest M. Hodnett and Donald A. Holmer (Oklahoma State Univ., Stillwater). [1960]. 11p.

A kinetic study was made on the reactions of phthaloyl chloride labeled with C^{14} in the carboxyl position with piperazine (polyamidation) and with 4,4′-isopropylidenediphenol (polyesterification). Phthaloyl chloride was dissolved in CCl_4 and the other reactant in basic aqueous solution, and the reactions were initiated by emulsifying the phases. The results show that both reactions at 0°C follow second-order kinetics throughout, whereas at 30 and 50°C they appear to decrease in rate beyond 80 to 90% reaction, and that the reaction rate depends on the reactant proportions. The apparent activation energies are 1.18 and 1.01 kcal/mole for the polyamidation and polyesterification reactions, respectively. No experimental isotope effect was observed in either reaction, whereas an isotope effect of 0.950 was observed in the monoamidation reaction of benzoyl chloride with morpholine. The first step in the mechanism appears to be migration of the difunctional amine or alcohol from the aqueous phase into the CCl_4 phase, with polymerization occurring in the CCl_4 phase near the interface. (D.L.C.)

14172 (TID-11932) RATES OF DISSOLUTION OF HAFNIUM METAL IN HYDROFLUORIC ACID. W. J. James, J. W. Johnson, and M. E. Straumanis (Missouri. Univ., Rolla. School of Mines and Metallurgy). [1960]. Contract AT(11-1)-73. 14p.

The rates of dissolution of crystal bar hafnium in hydrofluoric acid (0.050 to 1.00N) were determined from volume measurements of evolved hydrogen according to the established stoichiometry of the equation: $Hf + 4HF \rightarrow HfF_4 + 2H_2$. The reaction followed a first-order rate law for the entire concentration range. The rate of hafnium dissolution was dependent only upon the molecular HF concentration and independent of small additions of Na^+, K^+, F^-, H^+, NO_3^-, Bi^-, $C_6H_5O_7^{3-}$ to the acid. Large additions of alkali fluorides resulted in passivation of the metal surface by fluohafnates. The extent of passivation was determined by the relative solubilities of the salt layers in aqueous HF. Small additions of $Cr_2O_7^{2-}$, MnO_4^-, and BiO_3^- caused a decrease in the rate of hydrogen evolution. Addition of equivalent amounts of noble metal salts resulted in passivation of the metal surface. Platinum was most effective, followed by silver and gold. The slow step of dissolution was apparently controlled by the diffusion of un-ionized HF through a protective layer to attack the metal surface. Support for this concept was evidenced by the first-order rate dependence of un-ionized HF and the relatively small activation energy of 5.3 ± 0.5 kcal obtained in both hydrofluoric and hydrofluoric-hydrochloric acid mixtures. (auth)

14173 (TID-12096) OSMOTIC COEFFICIENTS OF HYDROCHLORIC ACID, POTASSIUM AND SODIUM CHLORIDES FROM 0° TO 40 OR 50°. Herbert S. Harned (Yale Univ., New Haven). Feb. 17, 1961. Contract AT(30-1)-1375. 7p.

Osmotic coefficients of hydrochloric acid and sodium chloride were tabulated over the temperature range from 0 to 50°C. Those for potassium chloride were collected for the range from 0 to 40°C. A comparison of sodium chloride and potassium chloride osmotic coefficients derived from electromotive force measurements with those obtained by the isopiestic vapor pressure method is presented. (M.C.G.)

14174 (TID-12097) THE ACTIVITY COEFFICIENT OF HYDROCHLORIC ACID IN ORGANIC SOLVENT–WATER MIXTURES. Herbert S. Harned (Yale Univ., New Haven). Feb. 17, 1961. Contract AT(30-1)-1375. 12p.

The values of the activity coefficient of hydrochloric acid in aqueous solutions containing organic molecules were collected and assembled into tables. All data were derived from measurements of the cells $H_2|HCl(m)$, solvent (X), $H_2O(X)|AgCl-Ag$ at 1 atm. The activity coefficients were determined for mixtures of water with dioxane, methanol, d-glucose, d-fructose, d-sorbitol, ethanol, 2-propanol, glycerol, and ethylene glycol. (M.C.G.)

14175 (TID-12110) APPLICATIONS OF RADIOISOTOPES TO CHEMICAL PROBLEMS. Progress Report for period March 1, 1960–March 1, 1961. (Wisconsin. Univ., Madison). Mar. 1, 1961. Contract AT(11-1)-32. 11p.

Results are discussed for investigations on: the metastable defects produced in crystalline C_2Br_6 by the $Br^{81}(n,\gamma)Br^{82}$ process; the influence of gamma rays and heat treatment on recoil Br^{82} atom reactions in crystalline C_2Br_6; photochemical reactions of iodine with ethyl alcohol, ethyl ether, and isopentane at 20 to –190°C at 4000 to 5000 A; HCl-catalyzed radiation-induced isomerization of normal propyl chloride to isopropyl chloride; the radiolysis of normal propyl bromide and ethyl iodide glasses; the activation of iodine as alkyl iodides and as iodine molecules in dilute solution in hydrocarbons by neutron capture; the ac-

tivation of iodine molecules by 1849 A radiation; and the testing of an electron spin resonance spectrometer. (B.O.G.)

14176 (TID-12142) THE PHOTOCHEMICAL AND THERMAL NITRATING PROPERTIES OF $UO_2(NO_3)_2 \cdot H_2O \cdot N_2O_4$. Technical Progress Report. John R. Lacher (Colorado. Univ., Boulder). Feb. 1961. 21p.

The reaction of $UO_2(NO_3)_2 \cdot N_2O_4 \cdot H_2O$ with 2,4-dichloroaniline. The reaction was studied in absolute EtOH and n-BuOH. Preliminary studies in EtOH indicated that the reaction was first order in each reactant and resulted in the formation of bis(2,4-dichlorophenyl)triazene. However it was found that the uranyl complex reacts with EtOH and n-BuOH to form an alkyl nitrite, which then reacts with the aromatic amine. The reaction order was determined by varying the initial reactant concentrations; results were poor with EtOH, while those with n-BuOH indicated that the reaction is second order in the alkyl nitrite and ~2/3 order in 2,4-dichloroaniline. The observed rate law is consistent with a mechanism in which a nitrosamine is formed as an intermediate. The nitrating properties of $UO_2(NO_3)_2 \cdot N_2O_4 \cdot H_2O$. The effects of acetic anhydride on the formation of mononitration products by the reaction of the uranyl complex or $UO_2(NO_3)_2 \cdot 6H_2O$ with bezene, o-xylene, and toluene were studied. The results indicate that the reaction with the uranyl complex is more vigorous than with $UO_2(NO_3)_2 \cdot 6H_2O$ and that a depletion of the nitrating agent occurs in excess acetic anhydride. Photochemical nitration. A solution of dioxane, acetic anhydride, nitrobenzene or nitrotoluene, and the uranyl complex is formed, and half of this solution was illuminated at 0°C, while the other half was kept in the dark at 0°C as a control. The results indicate that photochemical reaction forms some p-dinitrated products in addition to the m-dinitrated products formed in the dark. Vapor pressure of uranyl nitrate solutions. Dynamic vapor pressure measurements at 0°C gave an unusual vapor pressure vs molality curve in which an anomalous dip occurs in the region of 1.3 molal. This anomaly may be due to the reaction $2UO_2^{2+} + H_2O \rightleftharpoons U_2O_5^{2+} + 2H^+$ being shifted to the left with increasing $UO_2(NO_3)_2$ concentration. (D.L.C.)

14177 (AEC-tr-4052) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi-Khimii, Volume II, No. 2, 1957. 380p. (PST Cat.-79)

A cover-to-cover translation of this journal containing 35 papers is presented. Separate abstracts were prepared for 6 of the papers. (M.C.G.)

14178 (AEC-tr-4052(p.185-95)) POLAROGRAPHIC STUDIES OF SALTS OF RARE-EARTH ELEMENTS AND THEIR SYSTEMS WITH SOME COMPLEX FORMING AGENTS. S. I. Yakubson and N. A. Kostromina. Translated from Zhur. Neorg. Khim., 2: No. 2, 349-54(1957).

The application of polarography to the study of complex compounds of rare earths was investigated. Data from previous investigations of the reduction process for the rare earth elements were in disagreement. Solutions of the chlorides of Nd, La, Ce, and Sm, as well as neodymium sulfate, in aqueous solutions with and without supporting electrolyte and with tetramethyl-ammonium iodide were examined by the polarographic method. It was established that no interaction occurred in the solutions between the salts mentioned and the indifferent electrolytes. For the solutions of rare earth salts investigated, one distinct wave was established corresponding to reversible reduction according to the reaction $M^{3+} + e \rightarrow M^{24}$. A wave corresponding to the metallic state was not found. The relation between height of wave and concentration of rare earth ions in solutions was established. On the addition of complexing agents to solutions of neodymium or cerium salts, the wave of the simple rare earth cation disappeared. However, the wave of the complex ion did not appear. (M.C.G.)

14179 (AEC-tr-4052(p.303-16)) CRYOSCOPIC INVESTIGATION OF THE SYSTEMS $ZrCl_4-POCl_3$; $HfCl_4-POCl_4$; $ZrCl_4-CH_3OH$; $HfCl_4-CH_3OH$ IN NITROBENZENE. I. A. Sheka and B. A. Voitovich. Translated from Zhur. Neorg. Khim., 2: No. 2, 426-33(1957).

Systems of zirconium or hafnium tetrachlorides and phosphorus oxychloride were examined by a cryoscopic method. The interaction between zirconium and hafnium tetrachlorides and methanol, in nitrobenzene, was also investigated. It was established that the complexes with methanol in nitrobenzene have a normal molecular weight. The specific electroconductivity of $ZrCl_4$ and $HfCl_4$ and their complexes with phosphorus oxychloride and methanol in nitrobenzene were determined. It was found that the specific conductivity of $HfCl_4$ solutions was somewhat higher than that of $ZrCl_4$ solutions. The existence of the complexes $ZrCl_4 \cdot 2CH_3OH$ and $HfCl_4 \cdot 2CH_3OH$ was established. It was found that the compounds $ZrCl_4 \cdot 2POCl_3$ and $ZrCl_4 \cdot POCl_3$, $HfCl_4 \cdot 2POCl_3$, and $HfCl_4 \cdot POCl_3$ exist simultaneously in the systems $ZrCl_4-POCl_3$ and $HfCl_4-POCl_3$. (M.C.G.)

14180 (AEC-tr-4052(p.332-44)) THE STATE OF SMALL AMOUNTS OF RADIOACTIVE ELEMENTS IN SOLUTIONS. I. E. Starik and A. V. Kositsyn. Translated from Zhur. Neorg. Khim., 2: No. 2, 444-51(1957)

A parallel investigation was made of the adsorption of ruthenium on glass and of its state in hydrochloric acid solutions. Glass samples, round, polished discs, were rotated in the investigated solution at the rate of 70 rpm, for 1 hr, then removed, rinsed with alcohol, dried, and their activity determined. The region of existence of ruthenium in colloidal form in these solutions was determined by the method of ultrafiltration. In solutions with a ruthenium concentration of 10^{-4} mol at certain pH values, coagulation of colloidal hydroxide could be observed. A characteristic peculiarity of ruthenium adsorption is the presence of a sharp maximum in a narrow pH range between 5 and 7. Beyond the boundaries of the maximum, the adsorption was insignificant. Adsorption attained its highest value under such conditions when 70 to 100% of the ruthenium is in the colloidal state. (M.C.G.)

14181 (AEC-tr-4052(p.368-71)) STUDY OF SOLUBILITY IN THE SYSTEM LITHIUM-CARBONATE-LITHIUM SULFATE-WATER AT 0°. R. E. Pliushchev and V. B. Tulinova. Translated from Zhur. Neorg. Khim., 2: No. 2, 467(1957).

Solubility in the system $Li_2CO_3-Li_2SO_4-H_2O$ at 0°C was studied by the isothermal method. The quantity of Li_2CO_3 present in the solution and in the "solid residue" (after its dissolution) was determined volumetrically by direct titration with hydrochloric acid. The Li_2SO_4 present was computed from the amount of SO_4^{2-} ion, which was determined as $BaSO_4$ by the usual gravimetric method. The solid phases of the system were Li_2CO_3 and $Li_2SO_4 \cdot H_2O$. Graphic representations of the system are included. (M.C.G.)

14182 (AEC-tr-4053) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, Volume II, No. 3, 1957. 404p. (PST Cat.-80)

A cover-to-cover translation of this journal containing 36 papers is presented. Four of these papers are covered by separate abstracts. (M.C.G.)

14183 (AEC-tr-4053(p.288-94)) A STUDY OF SOLUBILITY IN AQUEOUS SYSTEMS, FORMED FROM LANTHA-

ŢUM NITRATE WITH CERTAIN METALLIC NITRATES. . THE SOLUBILITY ISOTHERMS OF THE SYSTEM: $La(NO_3)_3-Mg(NO_3)_2-H_2O$ AT 25 AND 50°; $La(NO_3)_3-NH_4NO_3-H_2O$ AT 25°. G. G. Urazov and Z. N. Shevtsova. Translated from Zhur. Neorg. Khim., 2: No. 3, 655-8(1957).

The solubility isotherms of the systems $La(NO_3)_3-Mg(NO_3)_2-H_2O$ at 25 and 100°C and $La(NO_3)_3-NH_4NO_3-H_2O$ at 25°C were studied by the isothermic method. The composition of the solid phase was determined by chemical, thermographical, crystallo-optical, and graphical methods. (M.C.G.)

14184 (AEC-tr-4053(p.295-9)) A STUDY OF SOLUBILITY IN AQUEOUS SYSTEMS OF LANTHANUM NITRATE WITH CERTAIN METALLIC NITRATES. II. THE SOLUBILITY ISOTHERMS OF THE SYSTEM: $La(NO_3)_3-Ni(NO_3)_2-H_2O$; $La(NO_3)_3-Zn(NO_3)_2-H_2O$ AT 25°. G. G. Urazov and Z. N. Shevtsova. Translated from Zhur. Neorg. Khim., 2: No. 3, 659-61(1957).

The solubility isotherms of the systems $La(NO_3)_3-Ni(NO_3)_2-H_2O$ and $La(NO_3)_3-Zn(NO_3)_2-H_2O$ at 25°C were investigated. After equilibrium was reached, the liquid and the solid phases were separately analyzed. For concentrations of lanthanum nitrate between 2 and 55% and of nickel nitrate between 4 and 48% in the solution, the double salt formed had the composition $2La(NO_3)_3 \cdot 3Ni(NO_3)_2 \cdot 24H_2O$. (M.C.G.)

14185 (AEC-tr-4053(p.324-39)) SOME ELECTROCHEMICAL PROPERTIES OF THE SYSTEM $ZrCl_4-CH_3OH$ AND $HfCl_4-CH_3OH$. I. A. Sheka and B. A. Voitovich. Translated from Zhur. Neorg. Khim., 2: No. 3, 676-84 (1957).

The electric conductivity and ion transfer in the systems $ZrCl_4-CH_3OH$ and $HfCl_4-CH_3OH$ were studied. At the same temperature, the specific electric conductivity of concentrated solutions of $ZrCl_4$ was somewhat higher than the electric conductivity of $HfCl_4$. The specific electric conductivity increased rapidly with the increase in concentration of $ZrCl_4$ and $HfCl_4$, reaching a maximum at 0.8 to 1 mol/l, and then decreasing. The molecular electric conductivity increased also with increasing temperature. Data presented show that the electric conductivity is determined chiefly by the HCl liberated in the course of the interaction of $ZrCl_4$ or $HfCl_4$ with the CH_3OH. On the basis of results obtained in ion transfer studies, the hypothesis is advanced that the anions are $ZrCl_5^-$, $ZrCl_6^{2-}$, and $ZrCl_5CH_3O^{2-}$, and the cations are H^+ in dilute solutions and complex ions such as $ZrCl_3^+ \cdot NCH_3OH$ and $ZrCl_2^{2+} \cdot MCH_3OH$. (M.C.G.)

14186 (AEC-tr-4054) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, Volume II, No. 4, 1957. 442p. (PST Cat.-81)

A cover-to-cover translation of this journal containing 41 papers is presented. Six of the papers are covered by separate abstracts. (M.C.G.)

14187 (AEC-tr-4054(p.149-61)) STUDY OF CERIUM OXALATE. A. K. Babko and L. I. Dubovenko. Translated from Zhur. Neorg. Khim., 2: No. 4, 808-15(1957).

The solubility of cerium oxalate in nitric acid of various concentrations, at the ionic strength $\mu = 2$ was studied. The solubility product was calculated to be $3(\pm 1) \times 10^{-26}$. The equilibrium constant for the solubility reaction in the presence of common cation excess was calculated. The instability constant of the complexion $CeC_2O_4^+$ was determined to be $(0.9(\pm 0.3) \times 10^{-6}$. The solubility of cerium oxalate in the presence of a common anion in solutions of various pH (from 1.0 to 8.5) was studied. From the resulting data, the instability constant of the complex anion was calculated to be 1.7×10^{-3}. It was established that the solubility of $Ce_2(C_2O_4)_3$ decreases in the presence of small quantities of common ions, while, at a higher concentration of common ions it increases at the expense of complex anion formation. The solubility of $Ce_2(C_2O_4)_3$ was also studied in the presence of potassium, magnesium, aluminum, and iron salts. (M.C.G.)

14188 (AEC-tr-4054(p.423-6)) ZIRCONYL OXALIC ACID AND ITS PRODUCTION. L. M. Zaitsev, L. K. Shubochkin, and G. S. Bochkarev. Translated from Zhur. Neorg. Khim., 2: No. 4, 980-1(1957).

When concentrated alcoholic solutions of oxalic acid and zirconyl chlorides were mixed, a fine crystalline precipitate of zirconyl oxalic acid was formed. In order to obtain a large yield of product, it was necessary to introduce a four- or five-fold excess of oxalic acid instead of the stoichiometrically computed quantity, in accordance with the equation: $ZnOCl_2 + 2H_2C_2O_4 \rightarrow H_2[ZnO(C_2O_4)_2] + 2HCl$. The zirconyl oxalic acid was easily hydrolyzed by water with the formation of basic zirconyl oxalates. The thermal stability of zirconyl oxalic acid was found to be higher than that of oxalic acid. (M.C.G.)

14189 (AEC-tr-4056) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, Volume II, No. 6, 1957. 381p. (PST Cat.-83)

A cover-to-cover translation of this journal containing 35 papers is presented. Ten of the papers are covered by separate abstracts. (M.C.G.)

14190 (AEC-tr-4056(p.234-46)) THE STUDY OF COMPLEX COMPOUNDS OF NEODYMIUM, PRASEODYMIUM AND ERBIUM WITH CITRIC ACID, BY THE SPECTROPHOTOMETRIC METHOD. V. M. Peshikova and M. I. Gromova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1356-64(1957).

The changes in the absorption spectra of the Nd, Pr, and Er salts in the presence of citric acid were studied in order to investigate the possibility of using the absorption spectra to trace the formation of complexes of these elements. The element/acid ratio as well as the pH of the solution were found to influence the process of complex formation. This was shown by the shift of the absorption peaks of praseodymium and neodymium toward longer wave lengths and by the appearance of a new peak at maximal absorption of erbium in the region of the shorter wave lengths. From the shift of the absorption peaks of neodymium and praseodymium it was found that four complexes of these elements with citric acid exist within a certain range of pH values. A single complex compound of erbium was identified, by a shift of the absorption peak toward the short wave lengths of the spectrum. (M.C.G.)

14191 (AEC-tr-4056(p.349-53)) THE STATE OF MICROQUANTITIES OF RADIOELEMENTS IN SOLUTIONS. IV. THE STATE OF MICROQUANTITIES OF URANIUM IN SOLUTIONS. I. E. Starik and L. B. Kolyadin. Translated from Zhur. Neorg. Khim., 2: No. 6, 1432-5(1957).

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, Abstract no. 4528.

14192 (AEC-tr-4056(p.354-62)) STUDIES ON COPRECIPITATION OF CERIUM WITH TETRAVALENT URANIUM OXALATE. A. N. Kirgintsev and A. D. Gel'man. Translated from Zhur. Neorg. Khim., 2: No. 6, 1436-40 (1957).

The coprecipitation of cerium with tetravalent uranium oxalate from aqueous solutions was studied. This work was carried out with Ce^{144}, free of stable isotopes and sufficiently pure, radiochemically, for the experiments. It was found that cerium forms anomalous mixed crystals with the

tetravalent uranium oxalate. By precipitation of the U^{4+} oxalate without stirring, more than the equilibrium quantity of Ce^{144} was carried by the precipitate. The coprecipitation of cerium did not obey the logarithmic law. No lower limit of miscibility was observed in the system $U(C_2O_4)_2-Ce_2(C_2O_4)_3$. It is shown that in this system there exists an upper limit of miscibility which increases with the uranium concentration. (M.C.G.)

14193 (AEC-tr-4058) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, Volume II, No. 8, 1957. 439p. (PST Cat.-85)

A cover-to-cover translation of this journal including 35 papers is presented. Abstracts were prepared of 7 papers. (M.C.G.)

14194 (AEC-tr-4058(p.78-80)) A NEW HYBRIDIZATION FOR THE COORDINATION NUMBER 9 AND THE STRUCTURE OF THE TRICYCLOPENTADIENYL OF URANIUM. M. G. Shirmazan and M. E. Dyatkina. Translated from Zhur. Neorg. Khim., 2: No. 8, 1761-2(1957).

A configuration of hybridization with coordination number 9 but with C_{3h} symmetry was examined using Kimball's method. This configuration of hybrid orbitals was of interest in relation to the problem of the structure and the electron structure configuration of covalent compounds of the $(C_5H_5)_3U^+$ type. Results of the study indicated that by making use of the f-orbitals of uranium, three links of the central atom with each cyclopentadienyl ring directed in agreement with the geometric configuration of $(C_5H_5)_3U^+$ can be formed. (M.C.G.)

14195 (AEC-tr-4058(p.81-8)) THE HYDRATES OF AMMONIUM URANYL DIOXALATE. I. I. Chernyaev, V. A. Golovnya, and R. N. Shchelokov. Translated from Zhur. Neorg. Khim., 2: No. 8, 1763-7(1957).

The conditions for crystallization of hydrated ammonium uranyl dioxalate were followed and the crystals were then investigated from the chemical and thermographic point of view in order to determine the relative degree of stability of water in the compound. Three types of crystals were formed: thin filaments which formed a "cotton-like" deposit, hexagonal bipyramids, and prisms. Results of chemical analysis showed that all the water is removed from the dihydrate of ammonium uranyl dioxalate between the limits of 100 and 110°. (M.C.G.)

14196 (AEC-tr-4058(p.365-80)) SOLUBILITY IN THE QUATERNARY RECIPROCAL SYSTEM $UO_2(NO_3)_2 + H_2C_2O_4 \rightleftharpoons UO_2C_2O_4 + H_2(NO_3)_2$ AT 25°. K. A. Bol'shakov and S. S. Korovin. Translated from Zhur. Neorg. Khim., 2: No. 8, 1940-50(1957).

A study was made of the ternary systems limiting the quaternary reciprocal system $UO_2(NO_3)_2 + H_2C_2O_4 \rightleftharpoons UO_2C_2O_4 + H_2(NO_3)_2$. The study was made at 25°C and in the concentration range of HNO_3 between 0 and 22% and partially only up to 70%. It was established that the reaction proceeds almost entirely in the direction of uranyl oxalate formation, even at high HNO_3 concentrations. At a HNO_3 concentration higher than 47%, the formation of uranyl oxalate monohydrate takes place. The crystallization surface of uranyl oxalate was studied. The solutions with constant concentration of uranyl oxalate were plotted on the plane diagram of the system. (M.C.G.)

14197 AN ELECTRON SPIN RESONANCE STUDY OF NITRO GROUP ALKALI METAL INTERACTIONS IN AROMATIC HYDROCARBONS. Raymond L. Ward (Univ. of California, Livermore). J. Am. Chem. Soc., 83: 1296-1300(Mar. 20, 1961). (UCRL-6161-T)

The reaction of potassium and sodium with nitrobenzene, o-dinitrobenzene, m-dinitrobenzene, p-dinitrobenzene, symtrinitrobenzene, nitromesitylene, dinitromesitylene, and trinitromesitylene in 1,2-dimethoxyethane (DME) was carried out, and the resulting paramagnetic solutions studied using electron spin resonance techniques. The nitrogen hyperfine coupling constants were determined for each molecule, while proton hyperfine coupling constants were determined in a few cases. All polynitro compounds studied, except o-dinitrobenzene, possess only one nitrogen hyperfine interaction. This is in contrast to the results obtained in the electrolytic preparation of these free radicals by Maki and Geske who find two equal nitrogen coupling constants in each of the isomeric dinitrobenzenes. A comparison of the resulting hyperfine structure of the electrolytically and chemically produced free radicals is presented and a strong ion-pair theory proposed for the differences obtained. (auth)

14198 KINETICS OF HYDROLYSIS OF cis-DIFLUORO-BIS-(ETHYLENEDIAMINE)-CHROMIUM(III) CATION. Klaus R. A. Fehrmann and Clifford S. Garner (Univ. of California, Los Angeles). J. Am. Chem. Soc., 83: 1276-9 (Mar. 20, 1961).

The rates of release of fluoride by acid and base hydrolysis of cis-$[Cr(en)_2F_2]^+$ were determined over a range of pH 1 to 8. At 25° the pseudo first-order aquation rate constant for loss of the first fluoride in 0.1 f $HClO_4$ is 5.3×10^{-6} sec^{-1}, much less than the corresponding rate constants of cis-$[Co(en)_2F_2]^+$ and cis-$[Cr(en)_2Cl_2]^+$ in 0.1 f HNO_3. The Arrhenius activation energy is 23 ± 1 kcal./mole. The aquation of cis-$[Cr(en)_2F_2]^+$ is acid catalyzed like the cobalt analog but, unlike the dichloro cobalt and chromium analogs, presumably because the difluoro complexes aquate by a mechanism involving an intermediate reactive protonated complex. Cation-exchange and spectral evidence indicate that the aquation product is largely, if not entirely, cis-$[Cr(en)_2(H_2O)F]^{2+}$. Fluoride is taken up by one or more reaction products in later stages of the hydrolysis. The aquation appears not to be accelerated by visible light. (auth)

14199 STUDIES ON THE PRECIPITATION OF THORIUM HYDROXIDE. PART II. INTERACTION OF THORIUM CHLORIDE AND POTASSIUM HYDROXIDE. Rameshwar Prasad and Arum K. Dey (Univ. of Allahabad, India). J. Ind. Chem. Soc., 37: 747-52(Dec. 1960). (In English)

A quantitative study of the association of potassium and chloride ions with the precipitated material by the interaction of thorium chloride and potassium hydroxide solutions was made. The precipitation of thorium hydroxide is complete with 3.6 equivalents of alkali when the concentration of thorium salt solution is 0.0625M, and 3.8 equivalents when the concentration is 0.0156M. In both cases complete precipitation occurs in acidic medium. It was also noted that the association of potassium ions increases, in general, with increase in the quantity of alkali added while that of chloride diminishes under the same conditions. With increase in temperature and with higher dilution, the association of both ions diminishes. (auth)

14200 PHOTOLYTIC SEPARATION OF URANIUM FROM VANADIUM. I. B. Mishra, Balaram Sahoo, and D. Patnaik (Utkal Univ., Cuttack, India). J. Ind. Chem. Soc., 37: 753-4(Dec. 1960). (In English)

The separation of uranium from vanadium was carried out by photolysis in sunlight. For this purpose, solution mixtures of uranyl sulfate and vanadyl sulfate or ammonium vanadate, containing formic acid and ethanol, were exposed to sunlight. Pure uranium was precipitated in the form of the hydrated oxysulfate, leaving vanadium in solu-

ion. The influence of H^+ ion concentration, time period of exposure, and the percentage composition of ethanol on the recovery of uranium was investigated. (auth)

14201 THE CHEMISTRY OF FLUOCHLORATES. PART I. FLUOCHLORATES OF COPPER, ZINC, CADMIUM, NICKEL, COBALT, CALCIUM, STRONTIUM, BARIUM, AND LEAD. Asimbikash Ray and Grihapati Mitra (City Coll., Calcutta). J. Ind. Chem. Soc., 37: 781-4(Dec. 1960). (In English)

The fluochlorates of Cu, Zn, Cd, Pb, Ba, Ca, Sr, etc. are described. Cu, Zn, Ni, Cd, and Ca fluochlorates are soluble in water. The other fluochlorates are insoluble in water. From the x-ray data, Ni fluochlorate hexahydrate is found to be isomorphous with Zn monofluoroarsenate hexahydrate. Ni and Co fluochlorates crystallize with six or seven molecules of water. Fluochlorates are oxidizing agents. The soluble fluochlorates were found to form mixed crystals with the corresponding sulfates, fluoroberyllates, etc. (auth)

14202 PREPARATION OF URANIUM(IV) OXYACETATE. N. C. Naik, Balaram Sahoo, and D. Patnaik (Ravenshaw Coll., Cuttack, India). J. Ind. Chem. Soc., 37: 798 (Dec. 1960). (In English)

A method is outlined for preparing quantitatively $UO(CH_3COO)_2 \cdot 1.5\ H_2O$. In this method, a solution of $UO_2(CH_3COO)_2$ is subjected to photochemical reduction on exposure to sunlight and then to distillation under reduced pressure at ~80°C, whereby the oxyacetate is precipitated in fine form. The distillation is continued until the solution left is just enough to keep the precipitate moist, and then the compound is dried in vacuum. (D.L.C.)

14203 A NEW COMPLEX COMPOUND OF RHENIUM. R. D. Daftary and B. C. Haldar (Gujarat Coll., Ahmedabad, India and Inst. of Science, Bombay). J. Ind. Chem. Soc., 37: 803(Dec. 1960).

A method is outlined for the preparation of a new complex compound of rhenium, $[Re(OH)_2Cl_2DPO]_x$, where DPO is a molecule of diphenylcarbazone less one H atom. In this method, an acetone solution of diphenylcarbazide is added slowly to an ice solution of potassium perrhenate solution in 8 N HCl to precipitate deep violet solids, which are separated, redissolved, re-precipitated, and dried in vacuum. The value of x was determined from freezing point depressions to be 0.88, which suggests the formula $Re(OH)_2Cl_2DPO$ for the complex. The absorption spectrum of the complex is reported. (D.L.C.)

14204 FORMATION OF BIRADICALS IN GLOW DISCHARGE. SPECTROSCOPIC DETECTION THROUGH THE DIMERIZATES FORMED. H. Schüler and E. Lutz (Max-Planck-Gesellschaft, Hechingen, Ger.). Z. Naturforsch., 16a: 37-61(Jan. 1961). (In German)

In the positive column of a glow discharge diphenylene was detected by absorption in benzene, diphenyl, chlorobenzene, bromobenzene, and iodobenzene and anthracene in toluole, benzyl chloride, benzyl bromide, benzal chloride, and indene. The high occurrence of dimerization products of radicals in the plasma of the positive column suggested the interpretation of the substances observed as dimerizates of two radicals, C_6H_4 and $C_6H_4 \cdot CH_2$. The supposition that the continuum (W spectrum) lying between 3400 and 4400 A indicates the existence biradicals in the plasma finds a new obstacle in this investigation. (tr-auth)

14205 INVESTIGATION OF URANYL REACTION WITH CUPFERRON BY SPECTROPHOTOMETRIC AND SOLUBILITY METHODS. A. E. Klygin and N. S. Kolyada. Zhur. Neorg. Khim., 6: 216-21(Jan. 1961). (In Russian)

Spectrophotometric investigations revealed that soluble uranyl cupferronate $UO_2(C_6H_5N_2O_2)_2$, with a molar quenching coefficient of $(1.90 \pm 0.01) \times 10^3$ at 370 mμ and a formation constant of $K_0 = (1.1 \pm 0.5) \times 10^{11}$, was formed in the $UO_2Cl_2 - C_6H_5N_2O_2H - H_2O$ system. The solubility of ammonium uranyl cupferronate at 25°C was determined and the solubility product calculated to be $[NH_4^+][UO_2(C_6H_5N_2O_2)_2][C_6H_5N_2O_2^-] = (5.8 \pm 2.5) \times 10^{-10}$. (R.V.J.)

Analytical Procedures

14206 (KAPL-M-DPS-4) THE DETERMINATION OF OXYGEN URANIUM RATIOS IN BINARY OXIDE MIXTURES. D. P. Stricos (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 30, 1961. Contract W-31-109-Eng-52. 13p.

The polarographic method for the determination of hexavalent uranium in uranium oxide was applied to binary oxide mixtures. For uranium oxide–zirconium oxide, satisfactory results were obtained when the sample size was reduced by a factor of ten. The precision was somewhat poorer, but still adequate for the calculation of oxygen uranium ratios. Samples of uranium oxide-yttrium oxide were analyzed with no interference from the yttrium oxide. Samples containing ceric oxide could not be analyzed by this method. The ceric oxide converted some of the uranium to the hexavalent form causing the results to be high. (auth)

14207 (MLM-591) ANALYTICAL PROCEDURE MANUAL FOR A RADIUM RECOVERY PROCESS. R. W. Moshier (Mound Lab., Miamisburg, Ohio). Sept. 2, 1952. Contract AT(33-1)-GEN-53. 37p.

A compilation is given of analytical procedures used in the laboratory-scale separation of radium from sulfate-insoluble residues from African pitchblende processing. Included in five alternate procedures are quantitative analyses for silica, lead, copper, molybdenum, barium, nickel, calcium, magnesium, radium, moisture, water-solubles, nitrate, silver, manganese, zinc, carbon dioxide, sulfate, and chromium. (auth)

14208 (NAA-SR-Memo-1675) THE APPLICATION OF THE STERN-GERLACH EFFECT TO THE DETERMINATION OF GASEOUS SPECIES AT HIGH TEMPERATURES. T. A. Milne (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 28, 1956. 7p.

Methods for determining gaseous species at high temperatures are discussed. The methods include thermodynamic reasoning, spectrographic identification, mass spectrographic identification, determination of molecular weight of vapor, velocity selectors, and the Stern-Gerlach effect. This effect, the deflection of any neutral particle possessing a magnetic moment on passage through an inhomogeneous magnetic field, is considered in detail. The application of the Stern-Gerlach effect to the determination of gaseous species depends on the distinct differences in magnetic movements which exist between various possible atoms and molecules in the gas phase. The method was found to be especially suited to a study of the species in the vapor over pure metals. (M.C.G.)

14209 (PG-Report-155(Rev.)) ANALYTICAL METHODS FOR THE DETERMINATION OF CAESIUM-137, STRONTIUM-89 AND -90 IN RAIN, LAKE AND SEA WATER. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1960. 19p.

Sr^{89}, Sr^{90}, and Cs^{137} together with added carriers were coprecipitated on larger amounts of calcium and potassium from lake and rain water. After radiochemical purification the β activities due to Sr^{89} and Cs^{137} were measured, Y^{90}

was separated and its activity measured to determine the Sr^{90} content of the samples. Sea-water samples were analyzed in a similar manner. (M.C.G.)

14210 (CISE-83) A BIBLIOGRAPHIC SEARCH ON RADIOACTIVATION ANALYSIS. F. Gadda, comp. (Centro Informazioni Studi Esperienze, Milan). Jan. 1961. 72p.

A bibliographic survey containing 471 references to works published up to October 1960 is presented. The lists include the references in the alphabetical order of the authors' last names, the reports that are reviews or papers of general interest, the elements determined, the analyzed materials, the analyses that used particles from accelerators, industrial applications of activation analyses, and chemical-physical determinations by activation analysis. (M.C.G.)

14211 (TID-11941) COULOMETRIC ANALYSIS OF RARE-EARTH ELEMENTS AT CONTROLLED POTENTIAL. A Proposal for Research Extending Contract AT(11-1)-553 and A Report of the Progress Made from February 20, 1960 to February 20, 1961. Edward N. Wise (Arizona. Univ., Tucson). Feb. 22, 1961. 30p.

Because ytterbium in the presence of europium had a potential lower than that when europium was absent, a study was initiated on the reversible nature of these reductions. The following devices were developed for the work: an electrolysis cell for measurements on deaerated solutions, a direct-reading coulometer, and a differential polarograph for distinguishing two electroactive species whose reduction or oxidation potentials are nearly the same. Work is now being done on the standard potentials and complexes of europium and ytterbium. (D.L.C.)

14212 (AEC-tr-4053(p.358-63)) THE UTILIZATION OF RETARDED BETATRON RADIATION FOR THE DETERMINATION OF THE OXYGEN CONTENT IN SEMICONDUCTING AND METALLIC MATERIALS (WITH SPECIAL REFERENCE TO OXYCARBIDES OF TITANIUM). A. Kh. Breger, B. F. Ormont, V. S. Kutsev, B. I. Viting, and B. A. Chapyzhnikov. Translated from Zhur. Neorg. Khim., 2: No. 3, 696-703(1957).

The development of a radioactivation method for determining non-metallic admixtures (particularly oxygen) in metals and semiconductors was investigated. A method was worked out for the determination of oxygen in titanium and its oxides and oxycarbides in which the reaction $O^{16}(\gamma,N)O^{15}$ was used. Advantages listed for the method include speed of determination, possibility of repeated determinations in one preparation, and preservation of the preparation analyzed. (M.C.G.)

14213 GAS CHROMATOGRAPHIC ANALYSIS OF SOME VOLATILE PHOSPHORUS COMPOUNDS. S. H. Shipotofsky and H. C. Moser (Kansas State Univ., Manhattan). Anal. Chem., 33: 521-3(Apr. 1961).

A rapid gas chromatographic method of analysis for mixtures of phosphorus trichloride–thiophosphoryl chloride, phosphorus trichloride–phosphoryl chloride, and dimethyl phosphite–diethyl phosphite was developed. The area per cent of each peak of the chromatogram closely agreed with the weight per cent of the corresponding component of the mixture. The column and detector used with the reactive inorganic compounds were constructed from inert materials. Described is a simple, yet dependable, thermal conductivity cell made from borosilicate glass with tantalum filaments. (auth)

14214 ELECTROCHROMATOGRAPHIC SEPARATION OF SILVER AND THALLIUM IONS FROM EACH OTHER AND FROM MIXTURES OF VARIOUS POLYVALENT CATIONS. Harold H. Strain, John F. Binder, C. Harlowe Evans, Harlan D. Frame, Jr., and John J. Hines (Argonne National Lab., Ill.). Anal. Chem., 33: 527-31(Apr. 1961).

Differential electrical migration in an ammoniacal solution of oxalate plus cyanide provides a complete separation of thallium ions from silver ions and from various polyvalent cations. Migration in an ammoniacal solution of ammonia–triacetic acid provides a complete separation of silver ions from thallium ions and from various polyvalent cations. Migration in ammoniacal oxalate solution provides a separation of silver plus thallium ions from various polyvalent cations. These migrations in the presence of complex-forming solutes are rapid and complete even at minute concentrations of the ions. (auth)

14215 USE OF CHLORINE IN CATION EXCHANGE SEPARATIONS. W. J. Blaedel and Eugene D. Olsen (Univ. of Wisconsin, Madison). Anal. Chem., 33: 531-4(Apr. 1961).

Chlorination of strong acid resins results in a significant decrease in the number of sulfonic acid groups, and is accompanied by an almost equal increase in the number of weak acid groups. Other effects of chlorination seem to be nuclear chloride substitution and the formation of pH-sensitive chromophoric groups. The consequences of these effects in using chlorinated resins for analytical separations are discussed. (auth)

14216 A SEPARATION OF BERYLLIUM FROM ALUMINUM, TRIVALENT IRON, YTTRIUM, CERIUM, AND THE RARE EARTHS BY CATION EXCHANGE CHROMATOGRAPHY. F. W. E. Strelow (South African Council for Scientific and Industrial Research, Pretoria). Anal. Chem., 33: 542-5(Apr. 1961).

A systematic study of the absorbabilities of cations with AG 50W-X8 resin in hydrochloric and nitric acids indicated that the difference in the equilibrium distribution coefficients among beryllium and a number of other cations is large enough to warrant a good separation. This fact was used to develop a cation exchange chromatographic procedure for the separation of Be from Al(III), Fe(III), Y(III), and Ce(III). Other elements that are completely separated include Sr(II), Ba(II), Ga(III), La(III), and the rare earths, Zr(IV) and Th(IV). A number of elements, such as Cd(II), Sn(IV), Se(IV), Hg(II), V(V), Mo(V), Au(III), As(III), and Sb(III), can be eluted from the column with 0.5N HCl before the separation of beryllium from the more strongly absorbed elements is started. The method of separation is applied to the determination of beryllium in a gadolinite ore. (auth)

14217 PAPER CHROMATOGRAPHIC SEPARATION AND COMPLEXOMETRIC TITRATION OF TRACE AMOUNTS OF STRONTIUM AND CALCIUM IN BIOLOGICAL MATERIAL. Pierre A. Dumont (Univ. of Louvain, Belg.). Anal. Chem., 33: 565-7(Apr. 1961).

A specific, sensitive, and simple method of simultaneously determining calcium and strontium in biological material is described. Samples are burned in a closed atmosphere of oxygen, then taken up in dilute HNO_3. An aliquot is submitted to ascending paper chromatography. Calcium and strontium are separated from each other, then recovered by calcination. Both elements are estimated by complexometric microtitration with EDTA, using calcein as indicator. Amounts of 25×10^{-9}M calcium and strontium are quantitatively recovered to within 1 to 2% and can be determined with a coefficient of variation of about 5%. For larger quantities, the reproducibility ranges from 1 to 4%. (auth)

14218 CATALYSTS FOR CERIUM(IV) OXIDIMETRY. DETERMINATION OF POLYHYDRIC ALCOHOLS AND METAL CHELATES OF 8-QUINOLINOL. G. G. Guilbault (Princeton Univ., N. J.). and W. H. McCurdy, Jr. Anal. Chem., 33: 580-2(Apr. 1961).

A silver(I)-manganese(II) catalyst system markedly increases the rate of oxidation of glycerol, erythritol, pentaerythritol, and 8-quinolinol by cerium(IV) sulfate in perchloric acid. Complete reaction requires only 3 to 5 minutes at 90°C, the end point being indicated by formation of the red color of permanganate. Glycerol (3 to 50 mg.), erythritol, or pentaerythritol (3 to 16 mg.) may be determined with a standard deviation of 0.3 to 0.5%; gallium(III), indium(III), aluminum(III), or magnesium(II) (0.05 to 5.0 mg.) may be determined after dissolution of the 8-quinolinol precipitates with a standard deviation of 1.0%. (auth)

14219 DETERMINATION OF OXIDE FILM THICKNESS BY PROTON ACTIVATION. Barbara A. Thompson (General Electric Co., Schenectady, N. Y.). Anal. Chem., 33: 583-6 (Apr. 1961).

A method was developed using a nuclear reaction for the determination of oxide film thickness on metals. The method is based on the activation of naturally occurring O^{18} with protons according to the reaction $O^{18}(p,n)F^{18}$. A measure of the positron radiation emitted by the F^{18} yields a measure of the amount of oxygen present in the film. The Brookhaven cyclotron was used as a proton source. With a proton energy of 4 Mev and a beam current of 10 μa, the lower limit of detection of the method corresponds to a thickness of the order of 1 A. The upper limit is approximately 10^5 A. Elements interfering with the measurement are copper, nickel, zinc, and titanium. Titanium can be eliminated by choice of a proton energy below 3.8 Mev. (auth)

14220 THE RADIOCHEMICAL DETERMINATION OF PROMETHIUM-147 IN FISSION PRODUCTS. R. D. Britt, Jr. (E. I. Du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem., 33: 602-4(Apr. 1961).

A solvent extraction method was developed for the determination of Pm^{147} in solutions of mixed fission products derived from irradiated natural uranium. Di(2-ethylhexyl)-orthophosphoric acid diluted with an inert diluent (Ultrasene) was used as the extractant. After separation, the Pm^{147} activity was determined by liquid scintillation counting. The precision of the method, based on six determinations was 3.2% at the 95% confidence limit. (auth)

14221 X-RAY FLUORESCENCE ANALYSIS USING ION EXCHANGE RESIN FOR SAMPLE SUPPORT. DETERMINATION OF STRONTIUM IN 0.1M CALCIUM ACETATE SOLUTIONS. Robert L. Collin (New England Deaconess Hospital, Boston). Anal. Chem., 33: 605-7(Apr. 1961).

An analytical method for the determination of trace amounts of an element in solution using x-ray fluorescence was developed. The solution to be analyzed is passed through an ion exchange column and the resin is removed, pressed into a pellet, and inserted into an x-ray spectrograph where the fluorescence intensities are measured. Variations caused by errors in weighing, loss of resin, and inhomogeneities in the pellet are corrected for by an internal standard which can be easily introduced directly onto the column. The method is illustrated with the determination of strontium in 10-ml samples of 0.1M calcium solutions. In a series of 16 such samples containing from 20 to 1000 μg of strontium (2 to 100 ppm) the standard deviation of the points from a straight line was 5.2% of the amount of strontium present. If background corrections are made, the method can be used for solutions having wide variation in major constituents. (auth)

14222 DETERMINATION OF RUTHENIUM TETROXIDE. Charles J. Anderson (Cross-Malaker Labs., Mountainside, N. J.), Richard Del Grosso, and Martin H. Ortner. Anal. Chem., 33: 646-7(Apr. 1961).

The combination of carbon tetrachloride extraction and colorimetric procedures provided the basis for a determination of ruthenium tetroxide. The main innovation is the stripping of the tetroxide from the tetrachloride using a solution of potassium hydroxide. (N.W.R.)

14223 CATALYSTS FOR CERIUM(IV) OXIDIMETRY. DETERMINATION OF PHOSPHITE, HYPOPHOSPHITE, TELLURIUM AND MERCURY. George G. Guilbault and W. H. McCurdy, Jr. (Univ. of Delaware, Newark). Anal. Chim. Acta., 24: 214-18(Mar. 1961). (In English)

A new catalytic oxidation procedure, involving the use of a cerium(IV) sulfate reagent in perchloric acid with a mixed silver(I)–manganese(II) perchlorate catalyst, was developed for the determination of phosphite, hypophosphite, and tellurium. By this method 15 to 100 mg of phosphite, 5 to 35 mg of hypophosphite, and 10 to 105 mg of tellurium may be determined with standard deviations of ±0.17, ±0.32, and ±0.21%, respectively. A direct titration procedure for mercury(I) is described using a ceric perchlorate solution as titrant with the mixed catalyst system. Samples from 65 to 510 mg may be analyzed with a standard deviation of ±0.36%. (auth)

14224 THERMOGRAVIMETRIC DETERMINATION OF MAGNESIUM, POTASSIUM AND LEAD BY PRECIPITATION WITH DILITURIC ACID. Alexandre Berlin and Rex J. Robinson (Univ. of Washington, Seattle). Anal. Chim. Acta., 24: 224-34(Mar. 1961). (In English)

The thermolysis curves of magnesium, potassium, and lead dilituratе have established that either the hydrated or anhydrous forms of these precipitates are stable enough for their gravimetric use to be possible. Magnesium and lead were determined by precipitation with dilituric acid, whereas potassium was precipitated with trimethylamine dilituratе. (auth)

14225 IDENTIFICATION OF PHOSPHATE ANIONS IN NIOBIUM AND TANTALUM PHOSPHATES BY MEANS OF INFRA-RED SPECTRA. S. Z. Haider (Dacca Univ., Pakistan). Anal. Chim. Acta., 24: 250-3(Mar. 1961). (In English)

Some niobium and tantalum phosphates were prepared and their infrared spectra were recorded and compared with those of reference substances. It was possible to identify PO_4^{3-}, $P_2O_7^{4-}$, and possibly $P_3O_{10}^{5-}$ groups, in different samples of niobium and tantalum phosphates. (auth)

14226 SPECTROPHOTOMETRIC STUDY OF THE BERYLLIUM–THORIN COMPLEX AND ITS APPLICATION TO THE DETERMINATION OF BERYLLIUM IN ALLOYS. V. T. Athavale, C. S. Padmanabha Iyer, M. M. Tillu, and G. M. Vaidya (Atomic Energy Establishment, Trombay, India). Anal. Chim. Acta., 24: 263-9(Mar. 1961). (In English)

A spectrophotometric study of the beryllium complex with purified thorin shows the formation of a I:I complex at pH 12. The dissociation constant obtained after successive corrections for reagent absorbance is 1.38×10^{-7}. Beryllium in concentrations of 0.05 to 2.0% in copper base, zinc base, aluminum base, and ferrous alloys can be determined by the formation of the thorin complex after its preliminary separation as acetylacetonate in presence of EDTA. (auth)

14227 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM WITH ASCORBIC ACID. G. E. Janauer and J. Korkisch (Universitat, Vienna). Anal. Chim. Acta., 24: 270-5(Mar. 1961). (In German)

A method is described for the spectrophotometric determination of niobium with ascorbic acid as reagent. A yellow color is formed with an extinction maximum at 345 mμ. (auth)

14228 THE DETERMINATION OF TRACE IMPURITIES IN HIGH-PURITY SELENIUM. A. I. Williams (National Physical Lab., Teddington, Middx, Eng.). Analyst, 86: 172-7(Mar. 1961).

Neutron-activation methods were developed for the determination of trace amounts of cadmium, copper, nickel, tellurium, and zinc in high purity selenium. The methods have sensitivities much greater than those of other analytical procedures. The lower limits of determination are 0.005 ppm of cadmium, 0.001 ppm of copper, 0.05 ppm of nickel, and 0.01 ppm of tellurium and zinc. (auth)

14229 COLORIMETRIC DETERMINATION OF URANIUM IN PHOSPHATE ROCK AFTER EXTRACTION WITH ALKYL ACID PHOSPHATES. W. B. Smith and J. Drewry (Marchon Products, Ltd., Whitehaven, Cumb., Eng.). Analyst, 86: 178-84(Mar. 1961).

A method for determining uranium in phosphate rock and phosphoric acid was developed. It is based on extraction of quadrivalent uranium by a solution of lauryl acid phosphates in light petroleum, this reagent being easily prepared from dodecanol and phosphorus pentoxide. The organic extract is evaporated to dryness, heated with nitric, sulfuric, and perchloric acids, and analyzed colorimetrically with hydrogen peroxide. (auth)

14230 DETERMINATION OF THE ^{14}C ACTIVITY IN SLIGHT QUANTITIES OF LOW-BOILING LIQUIDS. W. Schweers (Bundesforschungsanstalt für Forst- und Holzwirtschaft in Reinbek/Bez., Hamburg). Atompraxis, 7: 1-3(Jan. 1961). (In German)

For determining the C^{14} activity in small amounts of low-boiling liquids, it is advantageous to use suitably constructed measurement bowls in connection with a flow counter. These bowls can be closed with a lid containing a thin "window." With this method activity in a few milligrams of substance can be determined with an accuracy of ca. ± 3%. (auth)

14231 INVESTIGATIONS WITH IRIDIUM-192 OF SEPARATIONS OF PLATINUM AND RHODIUM FROM IRIDIUM. [PART] II. K. W. Lloyd and D. G. C. Morris (Brunel Coll. of Tech., London). Talanta, 8: 16-21(Jan. 1961). (In English)

Ir^{192} was used as a tracer in a study of the separation of platinum and rhodium from iridium by the use of HgCl or Hg_2Cl and hypophosphorous acid as a selective precipitant. Platinum may be separated satisfactorily from iridium by the use of either. In the presence of bromide, rhodium may be conveniently separated from iridium by precipitation using a slurry of HgCl. Iridium may be precipitated quantitatively by the slurry if iodide is present. A new rapid procedure for the separation of rhodium and iridium and subsequent determination of the two metals is proposed. (auth)

14232 CONTRIBUTIONS TO THE BASIC PROBLEMS OF COMPLEXOMETRY. IV. DETERMINATION OF THALLIUM. R. Přibil, V. Veselý, and K. Kratochvíl (Inst. of Geochemistry and Inorganic Chemistry, Academy of Sciences, Prague). Talanta, 8: 52-4(Jan. 1961). (In English)

It is shown that TlI, by evaporation with nitric acid, forms mainly $TlNO_3$ and not $Tl(NO_3)_3$. Only decomposition with aqua regia leads to the quantitative formation of trinitrate. Titrations of Tl^+ and Tl^{3+}, in alkaline medium using Eriochrome Black T, do not give reliable results, since the color change is not sharp enough. Titration with Xylenol Orange, in acid medium, is quite reliable, and permits the determination of Tl^{3+} in the presence of Tl^+. (auth)

14233 ANALYTICAL CHEMISTRY OF THE RARE EARTHS. R. C. Vickery. International Series of Monographs on Analytical Chemistry. Volume 3. New York, Pergamon Press, 1961. 146p. $6.50.

Methods and data are presented for the determination of rare earths. All phases of the problems from sample decomposition to ultimate element determination are treated. Some of the techniques considered include gravimetry, volumetry, spectrophotometry, spectrography, x-ray spectrometry, radiochemistry, and polarography. (D.L.C.)

General Inorganic and Physical Chemistry

14234 (ARF-3184-2) SCAVENGING OF RADIOACTIVE PARTICULATES AND AEROSOLS IN CONNECTION WITH NUCLEAR-POWERED SHIPS. John Rosinski (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Monthly Progress Report [for] October 1960. Nov. 10, 1960. 9p. Contract AT(11-1)-578.

Investigations were conducted on the scavenging of normal iodine and on the neutralization of silicon tetrafluoride scavenging systems. The best scavenger tested for iodine was a sea water mixture. A packed tower through which the mixture circulated removed all the iodine in the stream. Experiments were made to determine the effect of alkaline spray on neutralization of SiF_4. (W.L.H.)

14235 (NP-9906) HIGH TEMPERATURE CRYSTAL CHEMISTRY. Final Report Covering Period July 1, 1954 to September 30, 1960. (Brooklyn. Polytechnic Inst.). Contract AF18(600)-1193. 80p.

Work is reported on high temperature powder and single crystal chemistry. In crystal chemistry emphasis was on studies of thermal motions in crystals of simple structure, including calcite, sodium nitrate, and zinc blend. Powder work included studies of phase transitions in alkali-tungsten bronze, rare-earth silicides, and transition metal silicides and germanides. Associated with the studies of phase transitions was work on determination of solid solution limits, questions of stoichiometry, and correlation of variations in electrical properties with crystallographic order. (W.L.H.)

14236 (TID-3558) LITHIUM AND LITHIUM HYDRIDE CHEMICAL AND PHYSICAL PROPERTIES. A Literature Search. Theodore F. Davis (Office of Technical Information, AEC). November 1960. 26p.

The literature search consists of 187 references to report and published literature. The chemical properties considered are primarily those connected with corrosive reactions. (W.L.H.)

14237 (TID-11020) PHYSICAL CHEMISTRY OF THE SOLID STATE. W. J. Moore, J. J. Lander, S. R. Logan, M. O'Keeffe, J. S. Choi, Y. Ebisuzaki, S. Brown, and D. Mitchell (Indiana. Univ., Bloomington). Oct. 1, 1960. 50p. Contract AT(11-1)-250.

Single crystals of cuprous oxide were prepared by controlled oxidation of single crystals of 99.999% copper. The optical absorption of monocrystalline cuprous oxide was measured from 0.3 to 15 microns at 22 and −196°C. The

lectrical conductivity of monocrystalline cuprous oxide as measured over a wide range of temperatures and oxygen pressures. A quantitative explanation was given of the ctivation energies of the conduction processes. The diffusion of O^{18} in nickel oxide was measured. At 1300°C, the xygen diffusion coefficient is about 10^{-3} times the nickel iffusion coefficient. Additional measurements were made f diffusion of nickel in nickel oxide. A migration of metallic nickel in porous nickel oxide occurs at room temperature under the influence of an electric field. Frozen ydrocarbon targets were bombarded with ions of H^+, H_3^+, nd He^+ at energies about 5 kev in an apparatus designed o study radiation chemistry in this region of relatively low nergy. The effects of ionic bombardment on the properies of surfaces of aluminum and copper were studied by nethods of optical and electron microscopy and electron iffraction. (W.L.H.)

14238 (TID-11774) PHOTOCHEMICAL REACTIONS OF COMPLEX MOLECULES IN CONDENSED PHASE. Progress Report, May 1, 1960–April 30, 1961. Research Program and Budget, May 1, 1961–April 30, 1962. Henry Linschitz (Brandeis Univ., Waltham, Mass.). Feb. 15, 1961. Contract AT(30-1)-2003. 18p.

Flash-illumination work was continued in deoxygenated, purified solvents in studying the nature of the apparent first-order radiationless degradation of electronic excitation energy. The slow first-order decay rates for anthracene triplets in pyridine were established in hexane solutions, and the effect was also found for porphyrin triplets. Charge-transfer mechanism studies of triplet-state quenching by transition-metal ions showed that while ethylenediamine inhibited the quenching reaction, 1-10 phenanthroline did not inhibit the reaction. Triplet decay rates were measured for fluorescein, and tetrabromo- and tetraiodo-fluorescein. A study was begun of the properties of negative ions and ion-radicals of porphyrins, using the alkali-metal in polyether reagents. Work was continued on the "allomerization" reaction to prepare chlorophyll derivatives with known structural variations in the cyclopentanone ring. Observations were made of the transition between singlet and triplet states in the absorption spectra of copper tetraphenylporphine to determine the radiative transition probabilities. Spectrophotometric studies were continued on the nature of $FeCl_3$ solutions in organic solvents containing admixtures of complexing bases. Fluorescence spectra measurements of green plants at liquid nitrogen temperatures showed a strong emission band near 710 mμ. (B.O.G.)

14239 (TID-11821) PROGRESS REPORT TO THE ATOMIC ENERGY COMMISSION OF THE UNITED STATES [ON CHEMISTRY]. Technical Report No. 14. (Anderson Physical Lab., Champaign, Ill.). Jan. 1961. Contract AT(11-1)-544. 13p.

The conductivity apparatus was completely assembled and some preliminary work was done. In the zone refinement of KCl, a number of improvements were made in the apparatus as well as the zone melting procedure. Procedures using the cathode layer technique with a conventional arc source were worked out for cation analysis of KCl. (W.L.H.)

14240 (TID-11884) INVESTIGATION OF ENERGY TRANSFER PROCESSES BY FLASH PHOTOLYSIS. Progress Report No. 3. Leonard I. Grossweiner (Illinois Inst. of Tech., Chicago). Feb. 1961. Contract AT(11-1)-90. 39p.

An investigation of energy transfer processes in condensed substances is in progress. The specific systems studied are the optical bleaching of color centers in single crystals of potassium chloride and the oxidation of aqueous phenol photosensitized by fluorescein-type dyes. The reactants were placed in a suitable cell, irradiated with an intense light flash, and then the short-lived intermediate substances were measured. In the photosensitized chemical reaction the intermediates are metastable triplet molecules and free radicals, while in the color center transformation they are point-imperfections. (W.L.H.)

14241 (TID-12120) THE ELECTRONIC ABSORPTION SPECTRA OF SOME COVALENT INORGANIC COMPOUNDS. Gerald L. Carlson (Mellon Inst., Pittsburgh and Pittsburgh. Univ.). [Mar. 16, 1961]. Contract AT(30-1)-1993. 12p.

The low-dispersion electronic absorption spectra of nine covalent inorganic compounds were determined. Spectra are given for CrO_2Cl_2, ReO_3Cl, $TiBr_4$, and VCl_4 in the vapor state, and the molecular extinction coefficients of the maxima were calculated. The spectrum of ReO_3Br in CH_2Cl_2 solution was obtained but at an unknown concentration. $Si(NCO)_4$, $Ge(NCO)_4$, and $P(NCO)_3$ were found to be transparent above 2300 A, while $OP(NCO)_3$ exhibits one very weak band at 2660 A. (auth)

14242 (TID-12169) SOME OBSERVATIONS ON THE OXIDATION OF IODINE AT LOW CONCENTRATIONS. H. M. Eiland and Milton Kahn (Los Alamos Scientific Lab., N. Mex.). 1960. 15p.

Mild oxidation of "carrier-free" iodine-131 in aqueous solutions produced, among other uncharacterized species, one which was about equally soluble in benzene and 0.5M nitric acid. The species was not radio-colloidal in nature and comprised as much as 25% of the total activity in a reaction mixture. Some of the chemical and physical properties of the species are reported. Optimum conditions for the formation of the species were investigated. (auth)

14243 (AEC-tr-4250) ELECTRODE POTENTIALS OF SODIUM AND POTASSIUM IN LIQUID AMMONIA. W. A. Pleskow and A. M. Monossohn. Translated from Acta Physiochim. U.R.S.S., 2: 615-20(1935). 11p.

The standard potentials of sodium and potassium in liquid ammonia were determined by means of an amalgam electrode. It was found that in contrast to other elements which have more negative potentials in liquid ammonia, Na and K potentials are significantly higher and closer to the hydrogen potential. This apparently explains the stability of solutions of alkali metals in liquid ammonia. (auth)

14244 (AEC-tr-4350) ON THE ELECTROCHEMICAL BEHAVIOR OF METALS IN THE PASSIVE STATE. Ya. [Ia.] M. Kolotyrkin and V. M. Kniazheva. Translated from Zhur. Fiz. Khim., 30: (9), 1990-2002(1956). 15p. (In English)

The behavior of metals in passivating solutions was investigated by measuring anodic solution rates at constant potential. This method was used in studying the behavior of Ni and Cr electrodes in K_2SO_4 solution. The hypothesis is advanced that passivation of Ni and Cr in sulfate solutions is the result of activated adsorption of the oxygen of the water, increasing the overvoltage of ionization to the lowest oxidation state. (W.L.H.)

14245 (AEC-tr-4358) ABSORPTION OF UV IRRADIATION BY WATER. N. P. Grudinkina. Optika i Spektroskopiya 1: 658-62(1956). 8p.

The absorption indices of water of varying degrees of purity were determined in the uv region of the spectrum. Pure water does not have a selective absorption to 230 mμ. The possibility of using uv spectrophotometry for determining the degree of water purity is shown. (auth)

14246 (CEA-tr-R-1158) TENSION SUPERFICIELLE DU BERYLLIUM LIQUIDE. (Surface Tension of Liquid

Beryllium). V. (B.) N. Eremenko, V. I. Nizhenko, and Shou-wei T'ai (Tai Schou-Bei). Translated into French by B. De Trezvinsky from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 3, 116(1960). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 24608.

14247 (NP-tr-573) METHODS FOR THE PREPARATION OF DIBORANE. Translated from German Patent No. 1076103. Feb. 23, 1960. 9p.

The preparation is characterized by the reaction of B_2O_3 or borates with either boron, carbon, metal borides, metal carbides, or boron carbide as a reducing agent, and heated in hydrogen at 850 to 1500°C. Reaction equations are illustrated and sample preparations are described. (B.O.G.)

14248 (NP-tr-580) THORIUM AND ITS COMPOUNDS. D. I. Ryabchikov and E. (Ye.) K. Gol'braykh. Translated from Uspekhi Khim., 28: 408-35(1959). 43p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 18983.

14249 POLAROGRAPHY OF URANIUM(VI)-ETDA COMPLEXES. Donald G. Davis (Louisiana State Univ., New Orleans). Anal. Chem., 33: 492-4(Apr. 1961).

The polarography of uranium(VI) in solutions of EDTA was studied. The effect of pH on the half wave potential and the diffusion current constant was determined. The interference of a number of ions was investigated, and of these only copper and phosphate interfered seriously. They could be removed by solvent extraction prior to polarography. (auth)

14250 THE EFFECT OF THE NATURE AND THE CONCENTRATION OF THE ELECTROLYTE SUPPORT ON THE MORPHOLOGY OF THE POLAROGRAPHIC WAVES OF THE $Eu^{II}-Eu^{III}$. L. Gierst and P. Cornelissen (Université Libre, Brussels). Collection Czechoslov. Chem. Communs., 25: 3004-15(Dec. 1960). (In French)

The polarographic behavior of the system Eu(II)–Eu(III) is interpretated in terms of a slow electron transfer reaction, affected by the presence of the electrochemical double shell. (tr-auth)

14251 APPLICATION OF THE HANGING MERCURY DROP ELECTRODE TO AN INVESTIGATION OF REDOX PROCESSES OF URANIUM SALTS BY CYCLIC VOLTAMMETRY. W. Eemula, E. Rakowska, and Z. Kublik (Inst. of Physical Chemistry, Academy of Sciences, Warsaw and Univ. of Warsaw). Collection Czechoslov. Chem. Communs., 25: 3105-10(Dec. 1960). (In English)

The technique of cyclic polarization of a hanging mercury drop electrode was used in a study of the reversibility of the U^{4+}/U^{3+} couple and of the mechanism of U^{5+} disproportionation. Oxidation of U^{4+} at the electrode and chemical oxidation of U^{3+} were followed. (auth)

14252 THE DEPENDENCE OF THE MAGNETIC SCREENING OF F^{20} NUCLEI ON CONCENTRATION IN THE KHF_2-H_2O AND KHF_2-KF-H_2O SYSTEMS. I-tsu Wang and F. I. Skripov (Leningrad State Univ.). Doklady Akad. Nauk S.S.S.R., 136: 58-60(Jan. 1, 1961). (In Russian)

Chemical line displacement of F^{19} nuclear magnetic resonance in KHF_2-H_2O and KHF_2-KF-H_2O systems was analyzed at various concentrations in order to verify previous data. (R.V.J.)

14253 RESULTS OF LOW TEMPERATURE RESEARCH. XXXIII. THE VAPOR PRESSURE DIFFERENCE OF O_2^{16} AND O_2^{18} BETWEEN 63 AND 90°K. K. Clusis, F. Endtinger, and K. Schleich (Universitat, Zurich). Helv. Chim. Acta, 44: 98-105(1961). (In German)

The vapor pressures of natural O and a heavy O with 0.21% O^{16}, 0.15% O^{17}, and 99.64% O^{18} were compared between 63°K and the boiling point. The vapor pressure ratio was reduced to the pure isotopes. The boiling point of O_2^{18} is 0.105° higher than that of O_2^{16} (90.19°K). The vapor pressure difference of the two isotopes is 8.26 mm Hg at this temperature. The variation of the heat of vaporization is 6.28 cal/mol, with heavy O having the higher heat of vaporization. From the temperature dependence of the difference of the heat of vaporization, it resulted that the molecular heat of liquid O_2^{18} is greater by about 0.06 cal/mol at 90°K and about 0.12 cal/mol at 65°K. Under 63°K the true vapor pressure difference appears only slowly. Abnormally large, unreproducible values appear which are probably related with a hysteresis in the formation or decay of $(O_2)_2$ molecules. (tr-auth)

14254 DISSOLVING URANIUM IN NITRIC ACID. J. R. Lacher, John D. Salzman, and J. D. Park (Univ. of Colorado, Boulder). Ind. Eng. Chem., 53: No. 4, 282-4(Apr. 1961).

An investigation was undertaken to obtain information concerning the influence of various factors on the rate of dissolution of massive uranium metal in HNO_3. The initial rate increased with increasing carbon and nitrogen content. The amount of "work" the sample received increased the rate, particularly if the carbon content was high. Samples of metal which were worked also dissolved more rapidly along the axis of the rod from which they had been cut. The rate of the reaction increased as the reaction proceeded because of the accumulation of HNO_2 and an increase in surface area. With increasing concentration of HNO_3, the rate increased to a maximum at 13 to 14N, and then it decreased. The metal became passive in dilute acid. (auth)

14255 THE METAL BROMATE DECOMPOSITION REACTION IN FUSED ALKALI NITRATES. Frederick R. Duke and Walter W. Lawrence (Ames Lab., Ames, Iowa). J. Am. Chem. Soc., 83: 1269-71(Mar. 20, 1961).

The decomposition reaction: $6M^{2+} + 12BrO_3^- \rightarrow 6Br_2 + 15O_2 + 6MO$, where M^{2+} is cobalt, copper, nickel, or zinc ion, proceeds at a measurable rate in fused KNO_3-NaNO_3 or $LiNO_3-KNO_3-NaNO_3$ eutectics in the range 170 to 290°. A kinetic study of the reaction demonstrates that the mechanism consists of two steps: the fast equilibrium $M^{2+} + BrO_3^- \rightleftharpoons MBrO_3^+$ followed by the slow step $MBrO_3^+ \rightarrow$ decomposition products. The presence of the equilibrium is demonstrated by an experimental technique which leads to separation of the rate and equilibrium constants. Activation energies are also determined and relative reactivities of the four metal ions evaluated. The reactivities of various metal ions toward the reaction are interpreted on the basis of the following factors: (1) ability of the metal ion to complex with bromate in the fused nitrate solvent, (2) a favorable thermodynamic energy relationship between metal ion and its oxide and (3) the ability of the metal bromate complex to reach a favorable electronic configuration for decomposition to occur. (auth)

14256 REACTIONS IN FUSED SALTS. THE METAL–BROMIDE–BROMATE REACTION. Frederick R. Duke and Walter W. Lawrence (Ames Lab., Ames, Iowa). J. Am. Chem. Soc., 83: 1271-2(Mar. 20, 1961)

The reaction $3Zn^{2+} + 5Br^- + BrO_3^- \rightarrow 3ZnO + 3Br_2$ proceeds at a measurable rate in alkali nitrate eutectic solutions at 250°. A kinetic study of the reaction indicates that the mechanism involves two general steps: equilibria of the type $Zn^{2+} + nBr^- + mBrO_3^- \rightleftharpoons ZnBr_n(BrO_3)_m^{-(n+m-2)}$ followed by slow steps of the type $ZnBr_n(BrO_3)_m^{-(n+m-2)} \rightarrow$ decomposition products. The bromide further complicates the reaction by forming zinc bromide complexes which are

ert toward the reaction. Formation constants for these omplexes were evaluated from the kinetic data. (auth)

4257 REPLACEMENT OF POTASSIUM IONS IN SOLID OTASSIUM HEXATITANATE BY SODIUM IONS FROM A HLORIDE FLUX. Arthur L. Plumley and William C. Orr Univ. of Connecticut, Storrs). J. Am. Chem. Soc., 83: 289-91(Mar. 20, 1961).

Samples of fibrous potassium hexatitanate, $K_2Ti_6O_{13}$, ere heated in a flux containing various mixtures of radio- odium chloride, sodium chloride, and potassium chloride o study the replacement of potassium ions by sodium ions nd to attempt the preparation of sodium hexatitanate having ne same fibrous character as the potassium compound. An quilibrium constant of unity is indicated for the system $Na_{melt} + K_{solid} \rightleftharpoons Na_{solid} + K_{melt}$. The exchange studies sing $Na^{22}Cl$ in the melt and x-ray studies indicate prepara- ion of sodium hexatitanate. Preliminary microscopic ex- mination of the compound reveals that it too is fibrous in ature. (auth)

4258 TRANSFORMATION OF POLYMERIC RUTHE- IUM(IV) TO THE MONOMERIC SPECIES ON ION EX- HANGE RESIN. Donald K. Atwood and Thomas De Vries Purdue Univ., Lafayette, Ind.). J. Am. Chem. Soc., 83: 509(Mar. 20, 1961).

Ion exchange provided a simple method for transforming ne polymeric form to the monomeric. This was done by quilibrating a quantity of low crosslinked resin (2 to 4%) ith Ru(IV) solution known to contain extensive amounts of olymer and then eluting the resin with 0.1M $Ce(ClO_4)_3$ or M $HClO_4$. From direct observation of the spectrum of tu(IV) on the resin it is concluded that an actual trans- ormation of polymer to monomer occurs. (N.W.R.)

4259 REACTIONS OF GRAPHITE WITH OXYGEN. K. DUVAL (Faculte des Sciences, Nancy). J. chim. phys., 8: 3-11(Jan. 1961). (In French)

A review is given of the most recent results from studies of reactions between graphite and oxygen. The high-temper- ature reactions above 1000°C are first discussed. The reac- ions below 1000°C are reviewed by a critical examination of the experimental results obtained in the last few years. The various interpretations of the reaction mechanism are compared. The effect of diffusion, activation energy of the reaction, reaction order, the ratio CO/CO_2, role of surface oxides, and the effects of impurity inhibition and catalysis are discussed. (J.S.R.)

14260 THE REACTION OF GRAPHITE "WEAR DUST" WITH CARBON DIOXIDE AND OXYGEN AT LOW PRES- SURES. F. J. Vastola and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). J. chim. phys., 58: 20-4 (Jan. 1961). (In English)

The techniques of mass spectrometry were utilized to study the reaction of graphite "wear dust" with carbon di- oxide at pressures from 2.7 to 16μ of mercury and with oxygen at pressures from 30 to 35μ of mercury. The sen- sitivity of the measurement system is sufficient to permit the study of the reaction of carbon dioxide and oxygen at temperatures as low as 350 and 150°C, respectively. For carbon dioxide, it was found that the reaction is of the or- der of one with respect to the consumption of CO_2 at all temperatures studied. The rate of the production of carbon monoxide is almost double the rate of carbon dioxide con- sumption. The variation established is attributed to the chemisorption of a small quantity of carbon monoxide dur- ing the reaction. It was found that the reaction with oxygen is of the order of one with respect to the consumption of oxygen at a temperature of 500°C. However, at 200°C a decrease of the effective velocity constant because of the formation of a large quantity of a stable surface complex was noted. This surface complex has a variable activation energy of desorption. The reactions of the graphite wear dust are catalyzed by iron introduced in the material dur- ing the crushing process. A mechanism is proposed to ex- plain the catalytic activity of iron. (tr-auth)

14261 X-RAY STRUCTURE AND CHEMICAL REAC- TIVITY OF VARIOUS CARBON SAMPLES. E. Wicke, H. H. Kopper, and G. Wurzbacher. J. chim. phys., 58: 25-33 (Jan. 1961). (In French)

For the activation energy of the Boudouard reaction, val- ues between 40 and 100 kcal/mole were found in the litera- ture. Even for extremely pure samples, where no catalytic effect of impurities is to be considered, the activation ener- gies given by different authors vary so considerably that it was suggested that the reason might lie in differences in the crystalline structure of the samples caused by the prep- aration. The measurements made on activated carbon, lampblack, spectroscopically pure carbon for electrodes, and natural graphite have shown that there is no relation- ship between the degree of graphitization, the size of the crystallites, and the kinetic data. A mean value of 86 kcal/ mole was found for the activation energy. The cause of the differences among the values given in the literature can be caused, at least in high-purity samples, by the fact that the effect of diffusion in the pores was not taken into con- sideration. (tr-auth)

14262 DESORPTION OF OXIDES AT THE SURFACES OF SYNTHETIC GRAPHITES. Lucien Bonnetain (Faculte des Sciences, Nancy). J. chim. phys., 58: 34-46 (Jan. 1961). (In French)

The decomposition of surface oxides formed on artificial graphite during combustion at low oxygen pressure (less than 10^{-1} mm of Hg) was studied under various experimen- tal conditions. By progressive elevation of the temperatures to 950°C, the volatilization of most of the surface oxides is caused. The calculation made from the quantity of gas col- lected shows that these oxides cover only about $1/20$ of the total surface of the graphite sample. Because of the high sensitivity of the experimental method, the desorption of the surface oxides can be followed at the combustion tem- perature after evacuation of all the oxygen from the appara- tus. At a certain stage during the static desorption, CO and CO_2 are collected in a ratio equal to the coefficient of the relationship found between the formation velocities of CO and CO_2 during combustion. The total quantities desorbed (either as CO or CO_2) as a function of time obey the Elo- vich law. These results, as well as other observations, have led to the suggestion of a mechanism for the combus- tion of graphite where the formations of CO and CO_2 are not independent. (tr-auth)

14263 STUDIES OF THE INITIAL PHASES OF OXIDA- TION OF NUCLEAR GRAPHITE IN AIR AT TEMPERA- TURES BETWEEN 420 AND 650°C. E. Bauer (Commis- sariat à l'Énergie Atomique, Saclay, France). J. chim. phys., 58: 47-52(Jan. 1961). (In French)

The effect on the oxidation of graphite of several ppm of impurities and of the variation of various physical factors was studied. In some nuclear graphites there are impuri- ties, localized for the most part, in well-defined regions. The localizations were studied qualitatively and quantita- tively by means of emission spectroscopy, autoradiography, neutron-activation analysis, and x-ray radiography. The oxidation of these graphites is developed principally around these localizations, and in the presence of certain elements,

e.g., vanadium and sodium, the increase of velocity is such that it can lead to the formation of holes. The oxidation velocities of the various nuclear graphites studied can vary, according to their origin, by a factor of ten; after volatilization of the impurities, they draw closer together. During investigations on the variation of the oxidation velocity as a function of usage four types of curves to which all the phenomena observed seemed to be reducible were determined. The development of pores and chiefly the presence of impurities play a preponderant role. These factors appear to have a definite effect on the CO_2/CO ratio. Evolution of the B.E.T. surface as a function of usage, influence of the nature of the impurities on the ratio of the formation velocities CO_2/CO, effect of impurities on the inhibition caused by humidity, and oxidation of purified Madagascar monocrystals are also reviewed. (J.S.R.)

14264 THE ADSORPTION OF HYDROGEN OF GRAPHITE. W. J. Thomas (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. chim. phys., 58: 61-9 (Jan. 1961). (In English)

Some experiments relative to the adsorption of hydrogen on degassed graphite show that an activated adsorption is produced in the temperature range 600 to 750°C, whereas at −196°C little nonactivated rapid chemisorption was observed. By using a simple model for the adsorption of hydrogen, it was shown that the total number of carbon atoms at the edges, calculated from the degree of chemisorption at −196°C, is of the same order of magnitude of that obtained by x-ray study. The degree of adsorption in the range from 600 to 750°C is too great to be interpretated in a simple fashion as a function of the attack of free carbon atoms at the edge. After elimination of the surface oxygen (by making the graphite react with CO at 500°C), the supplementary quantity of adsorbed hydrogen at 700°C corresponds to the replacement of an oxygen atom with two hydrogen atoms. The results relative to the adsorption are discussed by supposing the presence of two types of vacancies for the carbon atoms at the edges, those which exist in the form of adjacent pairs and those which are isolated. (tr-auth)

14265 THE EFFECT OF CATALYSTS ON THE GASIFICATION OF GRAPHITE AND DIAMOND BY CARBON DIOXIDE. K. W. Sykes (Queen Mary Coll., London) and J. J. Thomas. J. chim. phys., 58: 70-6(Jan. 1961).

A comparative study was made of the effect of catalysts on the reaction of carbon dioxide at 10^{-2} mm and 800°C with graphite powder and diamond dusts. These materials have surface areas, determined by the B.E.T. method with argon, of 2.5 and 22 m^2g^{-1}, respectively. It is shown that all graphitization of the diamond during the reaction was less than the minimum detectable by photography of the powder with x rays. The velocity of the gasification per surface unit was, for the diamond, three times more than for the graphite. Iron that is 0.8% by weight (C:Fe = 580:1), added in the form of ferric nitrate in solution, increases by 100 times the gasification velocity of the diamond and 324 times that of the graphite. A catalysis of the reaction of the diamond by sodium carbonate could not be shown because it seems that the sodium carbonate disappears during degassing. The importance of these results is discussed by reference to the theories of the catalysis of the oxidation of carbon and to the usual points of view on the structure of the diamond. (tr-auth)

14266 ON THE GASIFICATION OF DIFFERENT VARIETIES OF CARBON AND GRAPHITE. Henri Guérin. J. chim. phys., 58: 77-85(Jan. 1961). (In French)

The principal works published since 1945 concerning the gasification of different varieties of carbon (other than graphite) by oxygen, carbon dioxide, water vapor, and sulfur, are analyzed. The mechanisms proposed, the kinetic interpretations of the results obtained, and the action of catalysts on these gasification reactions are indicated. The kinetic interpretations are, in reality, more complex than usually assumed because the gasification velocity is intimately connected with the porous structure, a structure which evolves during the gasification. 111 references. (tr-auth)

14267 ELECTRONIC AND PHYSICO-CHEMICAL BEHAVIOUR OF SOME LAMELLAR COMPOUNDS OF GRAPHITE. A. R. Ubbelohde (Imperial Coll. of Science and Tech., London). J. chim. phys., 58: 107-14(Jan. 1961). (In English)

Some comparisons were made between the lamellar crystalline compounds of graphite and intercalary compounds formed of a certain number of other crystals with shell structure. Although there is a certain number of resemblances, the graphite is almost unique with respect to the amphoteric character of its hexagonal lattices. They can be considered as aromatic macromolecules. In graphite, the interaction between these macromolecules is only weak. They preserve the essence of their aromatic structure in numerous crystalline compounds. Because of the aromatic character there is produced, in a distinct fashion, in the crystalline compounds a charge transfer between these macromolecules and various intercalary groups. This causes profound modifications in the electronic properties of solids. By interposing electron donor groups such as the atoms of an alkali metal or electron acceptor groups such as the halogens or acid radicals, a new class of very conductive solids is obtained. Anisotropic studies of the electrical properties of these solids parallel and perpendicular to the hexagonal layers of the carbon are analyzed. They give important information on the charge transfer to or from aromatic macromolecules. Impurities or crystalline faults of the original graphite modify the formation and the behavior of its crystalline compounds. Some impurity atoms at the edges can facilitate the intercalation of groups in the crystalline compounds and can also affect the electron levels in the macromolecules of carbon, modifying as a result the free bonding energy. Lattice faults can seriously perturb the planeity of aromatic lattices because of the impurity atoms bound to a hold or a prominence of the lattice. Spiral dislocations of the lattice were detected in some graphites. It is unknown to what extent these faults or other faults can affect the conclusions, based on crystalline compounds. (tr-auth)

14268 EFFECT OF INTERLAMELLAR BISULFATE IONS UPON THE FLEXURAL STRENGTH AND DIMENSIONS OF POLYCRYSTALLINE GRAPHITE. E. A. Kmetko (Los Alamos Scientific Lab., N. Mex.). J. chim. phys., 58: 115-19(Jan. 1961). (In English)

When polycrystalline graphite reacts with sulfuric acid to form interlamellar graphite bisulfate, modifications in the bend strength and the physical dimensions are observed. The bend strength increases with the degree of oxidation and attains a maximum selective value of approximately 1.25 for an ionic concentration of about 10^{-3} ion HSO_4^- per atom of carbon. The results are slightly different for lamellar and residue compounds, which denotes the existence of a relationship with the ionic distribution. The graphite, in the form of extruded rods, expands anisotropically. The expansion produced by chemical methods resembles the thermal expansion. The expansion depends on the ion distribution because it is weaker for residue compounds. It

s thought that these two effects can be attributed to the xpansion of graphite crystallites in the c direction. This xpansion is produced when the reagent penetrates into the raphite lattice. The increase of the bend strength is prob- bly the result of the decrease of the stresses, which are stablished because of the one-dimensional expansions of rystallites, as was proposed by Mrozowski and Mizushima o explain the relationship between the resistance of poly- rystalline graphite and temperature. (tr-auth)

4269 APPLICATION OF TOPOCHEMICAL PROPERTIES OF GRAPHITE IN STUDY OF GRAPHITIZABLE AND NON-GRAPHITIZABLE CARBONS. J. chim. phys., 58: 120-(Jan. 1961). (In French)

The application of topochemical reactions of graphite to nongraphitized carbons permits a distinction to be made between graphitizable and nongraphitizable carbons. In some cases the beginning of the graphitization can be detected. (tr-auth)

4270 GRAPHITE OXIDE AND ITS MEMBRANE PROPERTIES. H. P. Boehm, A. Clauss, and U. Hofmann (Universitat, Heidelberg). J. chim. phys., 58: 141-7(Jan. 1961). (In English)

In graphitic oxide, the oxygen is connected to carbon atoms in the form of hydroxyl and ether groups. It is possible to distinguish between hydroxyl groups of different acidity. The appearance of keto-enol transitions is very probable. At the periphery, the carbon layers have carboxyl groups. One of the most interesting characteristics of graphitic oxide is its power of intracrystalline swelling. Membranes of graphitic oxide are impermeable except for polar liquids as water. With these membranes it is easy to measure partial pressures of water vapor. They have also been used with success for the determination of osmotic pressures of high polymer solutions. Membranes of graphitic oxide are almost impermeable to anions, but permeable to cations. By utilizing electrodes with graphitic oxide membranes, partial differences of 57 to 58 mv were observed for an activity ratio $\underline{a}_1/\underline{a}_2 = 10$ with solutions of H^+ and other monovalent cations for a wide range of activities. The electrodes with graphitic oxide membranes are compared, with respect to their selectivity, with biological membrane electrodes. (tr-auth)

14271 THE SOLUBILITY OF METALS IN LIQUID METALS. D. H. Kerridge (University Coll., Legon, Ghana). J. Nuclear Energy, Pt. B. Reactor Technol., 1: 215-20 (Feb. 1961).

An account is given of some general conclusions reached from an examination of all available data on the solubility of metals in liquid metals. Solubility values were determined from published binary-phase diagrams. Solubilities show periodic variation with increase in atomic number of the solute, and this periodicity is broadly independent of the nature of the liquid metal. A correlation of solubility (x) is found with the solute lattice energy which, in turn, is proportional to the latent heat of fusion (L_f). Using as solutes any two transition elements which are horizontally adjacent in the periodic table, the value of $(\log_e x_2 - \log_e x_1)/(\text{Log}_{f_1} - L_{f_2})$ is nearly proportional to the absolute temperature for nine of the lower melting liquid metals. This fact may be used to estimate solubility values for which no measurements exist. A number of such estimates are given. (auth)

14272 SOME REACTIONS BETWEEN THORIUM OXIDE AND INHIBITED HEAVY LIQUID METALS. G. H. Broomfield, J. M. Matthews, and A. Bartlett (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. B. Reactor Technol., 1: 221-8(Feb. 1961). (AERE-12-3131)

As part of a study of liquid metal slurries as blanket materials for liquid metal fueled reactors, thoria prepared by calcination of the oxalate was mixed vigorously with inhibited lead, lead-bismuth eutectic, and bismuth at temperatures in the range 500 to 600°C to form slurries containing up to 18% (by volume) solids. Solidified samples were examined for reactions between the corrosion inhibitors (zirconium and magnesium) and thoria, immediately after preparation and after circulation in thermal convection loops and in a pumped loop. Magnesium at eutectic concentration in lead and bismuth reacted with thoria to produce intermetallic compounds which plugged thermal convection loops. Magnesium at normal inhibitor levels did not reduce thoria to give a thorium concentration in excess of the solubility limit in bismuth at 400°C. Thoria concentrations up to 7% in bismuth were not found to effect the rheological properties of the liquids in these experiments, nor to alter corrosion inhibition effects by the ZrN film technique. The rheology of lead slurries was influenced principally by thoria settling upwards. Apart from settling effects the slurries were physically stable. (auth)

14273 FORCES BETWEEN SLURRY PARTICLES DUE TO SURFACE TENSION. J. Woodrow, H. Chilton, and R. I. Hawes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Energy, Pt. B. Reactor Technol., 1: 229-37(Feb. 1961).

Equations are derived defining the shape of small bubbles or drops which may form between pairs of slurry particles, immersed in a liquid vehicle; the system considered is axially symmetric. The resultant bubble or drop shapes are also presented graphically. The force which a bubble or drop may transmit between particles is derived and evaluated for some particular cases of interest. In a system with only two components, any bubble must contain the vapour phase of the liquid vehicle, at reduced pressure. Such a bubble can only exist if the contact angle, measured in the liquid phase, exceeds 90° and it will always exert a cohesive force, holding the slurry particles in contact. Three component systems can be formed with bubbles or immiscible liquid drops joining adjacent slurry particles, provided that the contact angle is greater than zero, and they may transmit a cohesive force. This was demonstrated qualitatively by experiments with glass particles in water which flocculated heavily when shaken in air and dispersed when de-aerated, or when the contact angle was reduced to zero. When a liquid metal slurry is exposed to neutron irradiation, gas may be generated, and may cause flocculation by this mechanism. Degassing may prove to be difficult. (auth)

14274 THERMODYNAMIC PROPERTIES OF THORIUM DIOXIDE FROM 298 TO 1,200°K. Andrew C. Victor and Thomas B. Douglas. J. Research Natl. Bur. Standards, 65A: 105-11(Mar.-Apr. 1961).

As a step in developing new standards of heat capacity applicable up to very high temperatures, the heat content (enthalpy) of thorium dioxide, ThO_2, relative to 273°K, was accurately measured at ten temperatures from 323 to 1,173°K. A Bunsen ice calorimeter and a drop method were used to make the measurements on two samples of widely different bulk densities. The corresponding heat-capacity values for the higher density sample are represented within their uncertainty (estimated to be ±0.3 to 0.5%) by the following empirical equation (cal $mole^{-1}$ deg^{-1} at T °K): $C_p^0 = 17.057 + 18.06(10^{-4})\,T - 2.5166\,(10^5)/T^2$. At 298°K this equation agrees with previously reported low-temperature measurements made with an adiabatic calorimeter. Values of heat content, heat capacity, entropy, and Gibb's free energy function are tabulated from 298.15 to 1,200°K. (auth)

14275 TETRAGERMANATES OF STRONTIUM, LEAD, AND BARIUM OF FORMULA TYPE AB_4O_9. Carl R. Robbins and Ernest M. Levin. J. Research Natl. Bur. Standards, 65A: 127-31(Mar.-Apr. 1961).

Three new tetragermanates, $SrGe_4O_9$, $PbGe_4O_9$, and $BaGE_4O_9$, of formula type AB_4O_9 were found. $BaTiGe_3O_9$, the germanium analog of the mineral silicate benitoite ($BaTiSi_3O_9$) was prepared for study and comparison. Indexed x-ray powder diffraction patterns of the tetragermanates and of $BaTiGe_3O_9$ and $BaTiSi_3O_9$ show: (1) the tetragermanates are apparently isostructural; (2) the unit cell of $BaTiGe_3O_9$ at room temperature is related to that of the tetragermanates by a doubling of the c-axis of the latter; (3) the tetragermanates and the metastable (room temperature) form of $BaTiGe_3O_9$ are apparently structurally similar to, but not isostructural with benitoite; (4) within its temperature stability range, $BaTiGe_3O_9$ appears to be isostructural with $BaTiSi_3O_9$. Density, melting point, and partial optical data for the tetragermanates were obtained. (auth)

14276 STUDIES ON URANIUM (VI) COMPOUNDS WITH PHTHALIC ACID. Amar Jit Singh and N. S. Krishna Prasad (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India), 20B: 104-8(1961). (In English)

Potentiometric and spectrophotometric studies on uranium(VI)-phthalic acid systems indicate the formation of a soluble uranyl phthalate complex and an insoluble ammonium salt. Based on x-ray and chemical analyses, and substantiated by the potentiometric data, the structure for the insoluble compound was discussed and a dimeric molecular formula $(NH_4)_2\,[C_6H_4\,(COO)_2]_2\,U_2O_5$ was assigned. (auth)

14277 THE QUESTION OF THE SOLUBILITY OF RARE GASES IN SALT MELTS. H. U. Woelk (Hahn-Meitner-Institut fur Kernforschung, Berlin). Nukleonik, 2: 278-9(Dec. 1960). (In German)

A study was made to determine which characteristics of salt melts affect their solvent properties for rare gases. The solubility of Ar in various potassium salt melts was graphed as a function of the temperature. Other rare gases show a similar solubility curve. It is shown that no significant relationship exists between the solubility K_c and the free volume v_f calculated on the basis of pure geometric considerations. The slope of the line $K_c = \underline{f}(v_f)$ decreases with increasing radius of the rare gas atoms and is therefore a linear function of the radius of the rare gas atom. These results are interpreted by splitting the Henry constant into two parts. (J.S.R.)

14278 Ti(IV) AND Zr(IV) POLAROGRAPHY IN A METHYL AND WATER–ALCOHOL MEDIUM. Pier Giorgio Desideri and Francesco Pantani (Universita, Florence). Ricerca sci., 30: 2000-8(Dec. 1960). (In Italian)

The behavior of $TiCl_4$ and $ZrOCl_2$ is investigated polarographically in a methanol and water-alcohol medium. Ti(IV) is reversibly reduced to Ti(III) at the mercury drop electrode, in a solution of absolute methanol. The ZrO^{2}-ion is reduced neither in an alcoholic nor in a water alcohol solution. The currents of diffusion recorded by polarographing the solution of $ZrOCl_2$ in methanol are due to the catalytic reduction of the hydrogen ions formed by the hydrolysis of the zirconyl chloride. The reduction of Ti(IV) and the hydrolysis currents of $ZrOCl_2$ are studied within a wide range of concentration of chlorine ions, acidity and water. Also the conditions for the dosage of the two elements are established. (auth)

14279 THE VIBRATIONAL SPECTRA OF VANADIUM OXYTRIBROMIDE AND ARSENIC TRIBROMIDE. Foil A. Miller and William K. Baer (Mellon Inst., Pittsburgh and Univ. of Pittsburgh). Spectrochim. Acta, 17: 112-20(Feb. 1961).

The infrared spectrum of $VOBr_3$ was obtained from 75 to 3000 cm^{-1}. The fundamental frequencies are, for C_{3v} symmetry, a_1 = 1025, 271 and 120 cm^{-1}; e = 400, 212, and 83 cm^{-1}. For $AsBr_3$ the infrared spectrum from 75 to 800 cm^{-1}, and the Raman spectrum with polarizations, were measured. A reassignment of the fundamentals gives a_1 = 284 (estimated) and 128 cm^{-1}; e = 275 and 98 cm^{-1}. (auth)

14280 THE OPTICAL SPECTRUM OF URANIUM IN THE 1-2·5 μ REGION. L. Bovey, N. Atherton, and E. B. M. Steers (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Spectrochim. Acta, 17: 259-78 (Mar. 1961). (In English)

A list of 500 U^{238} wavelengths and some associated isotope shifts for $U^{238}-U^{235}$ are given together with a short discussion on possible use of lines in this region for isotopic abundance measurements. From a study of the data, levels from the f^4s^2 configurations do not lie near those from the ground state in UI. Some assignments of the lines as transitions between known levels are made and the existence of levels at 10,347.3 cm^{-1} and 11,545.4 cm^{-1} is doubted. (auth)

14281 OPTICAL ABSORPTION SPECTRUM OF γ-IRRADIATED CRYSTALLINE GLYCINE. G. W. Chantry and D. H. Whiffen (National Physical Lab., Teddington, Middx, Eng.). Spectrochim. Acta, 17: 367-8(Mar. 1961). (In English)

Glycine crystals were irridiated to a dose of 5Mr of γ rays. Crystals were a dark brown color when cold, but on warming to room temperature they rapidly turned pale yellow. Electron spin resonance and optical spectra were taken. The electron spin resonance spectrum showed that the only free radical species present was $NH_3^+CHCO_2^-$. The crystal had absorption maxima at 2600 and 3300 A, the former being twice as intense as the latter. Heating the crystals showed that changes occurring in the spectrum were caused only by the free radical $NH_3^+CHCO_2^-$. (N.W.R.)

14282 THE ATTACHMENT OF RADIOACTIVE ATOMS TO AEROSOLS OF SIZE 0.7 TO 5μ. Lars Lassen and Hermann Weicksel (Universität, Heidelberg, Ger.). Z. Physik, 161: 339-45(1961). (In German)

The attachment of the decay products of thorium emanation to aerosol particles was studied. The dependence of the attached activity on the particle size was determined for spherical particles with radii ranging from 0.7 to 5μ. The particles used were solid spheres of paraffin wax. It is found that the attached activity is proportional to the radius of the particles, which is in good agreement with theory in this size range. (auth)

14283 STABILITY OF COMPLEX COMPOUNDS OF La, Ce, Pr, AND Nd WITH ASPARTIC ACID. I. M. Batyaev, S. V. Larionov, and V. M. Shul'man. Zhur. Neorg. Khim., 6: 153-6(Jan. 1961). (In Russian)

The acidic dissociation constants for aspartic acid were verified, and the first and second stability constants of complex lanthanum, cerium, praseodymium, and neodymium compounds with aspartic acid were determined at 25°C and ionic strength μ = 0.1. It was found that the stability of the above complex compounds is quite close for cerium, praseodymium, and neodymium, and regularly increases from lanthanum to neodymium. It is postulated that the reaction of La^{3+}, Ce^{3+}, Pr^{3+}, and Nd^{3+} with aspartic acid is not limited to the formation of MA^+ and MA_2^- type complexes. (R.V.J.)

14284 KINETICS OF CATHODE AND ANODE POLARIZATION OF URANYL ION PHOSPHORIC ACID SOLU-

ION. Ya. P. Gokhshtein and Kao Ts'ai-sheng (Vernadskii ıst. of Geochemistry and Analytical Chemistry, Academy f Sciences, USSR). Zhur. Neorg. Khim., 6: 157-61(Jan. 961). (In Russian)

The mechanism of UO_2^{2+} reduction at a mercury electrode in 1M H_3PO_4 + 0.25M K_2SO_4 was analyzed. Only one athode wave of uranium was observed on the current-otential curve. The reduction of hexavalent uranium to etravalent is an irreversible process. The rate constants nd free energy for a single-step cathode process are alculated. (R.V.J.)

14285 PHASE EQUILIBRIUM OF CRYSTAL-LIQUID IN BINARY SYSTEMS OF $ZrCl_4$, $HfCl_4$, $SnCl_2$, $ZnCl_2$, AND $BiCl_3$. L. A. Nisel'son, B. N. Ivanov-Emin, and L. E. Larionova. Zhur. Neorg. Khim., 6: 186-91(Jan. 1961). (In Russian)

The liquidus phase temperatures for $ZrCl_4$, $HfCl_4$, $SnCl_2$, $ZnCl_2$, and $BiCl_3$ were determined. It was found that $ZnCl_2-Zr(Hf)Cl_4$, $BiCl_3-Zr(Hf)Cl_4$, $ZnCl_2-SnC_2-ZrCl_4$ are eutectic systems in which an incongruently melting compound $SnCl_2 \cdot 2ZrCl_4$ is formed. The $SnCl_2-HfCl_4$ system is related to the $SnCl_2 \cdot 2HfCl_4$ compounds, which melt congruently at an intermediate point. Congruently melting $BiCl_3 \cdot 2SnCl_2$ is formed in the $SnCl_2-BiCl_3$ system. It was also found that $SnCl_2$ has good solvent properties for zirconium and hafnium tetrachlorides. Hence, $SnCl_2$ and eutectic $ZnCl_2$ may be used for $ZrCl_4$ and $HfCl_4$ separation by extractive rectification. (R.V.J.)

14286 SOLUBILITY ISOTHERM OF $UO_2(NO_3)_2-Be(NO_3)_2-H_2O$ AT 0° AND 25°. M. A. Yakimov and N. F. Nosova. Zhur. Neorg. Khim., 6: 208-11(Jan. 1961). (In Russian)

A specially prepared tetrahydrate of beryllium nitrate with 4.37% beryllium (theoretically 4.39%) and 60.40% NO_3^- (theoretically 60.48%) was used in the experiment. The composition of the solution and the donor phases were determined by beryllium hydroxide precipitation from oxalic acid followed by uranium precipitation from the filtrate in the form of uranyl orthoxyquinolinate. The data on $UO_2(NO_3)_2-Be(NO_3)_2-H_2O$ solubility at 0 and 25° are tabulated and analyzed. (R.V.J.)

14287 COMPOSITION OF BERYLLIUM VAPOR. O. T. Nikitin and L. N. Gorokhov (Moscow State Univ.). Zhur. Neorg. Khim., 6: 224-5(Jan. 1961). (In Russian)

Tabulated data on the mass spectrum of beryllium vapors show that molecular beryllium is the only component at the melting point, 1556°K, and above. The intensity of the ion current, m/q = 18, depends on the H_2O^+ ion. (R.V.J.)

14288 PRASEODYMIUM AND NEODYMIUM TANTALATES. E. I. Krylov and M. M. Sterlina (Ural Polytechnic Inst., [USSR]). Zhur. Neorg. Khim., 6: 235-6(Jan. 1961). (In Russian)

The synthesis of praseodymium and neodymium orthotantalates and their magnetic properties are described. It was found that the magnetic susceptibility of both salts at 78 to 290°C follows the Curie-Weiss law. (R.V.J.)

14289 PREPARATION OF LANTHANUM HEXABORIDES. G. V. Samsonov, Yu. B. Paderno, and S. U. Kreingol'd (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, USSR). Zhur. Priklad. Khim., 34: 10-15(Jan. 1961). (In Russian)

Preparation of lanthanum hexaborides by lanthanum oxide reaction with boron carbide or boron was studied. The influence of temperature on the final produce was determined. It is shown that both reductions can be used. Lanthanum oxide reduced by boron is free from carbon admixtures. The approximate magnitude of the hexaboride heat of formation was found to be (−112.3 ± 6.5 kcal/mol). The temperature dependence of heat capacity was 21.73 + $20.4 \times 10^{-3} \cdot T$ cal/mol/degree. (R.V.J.)

14290 REDUCTION OF URANIUM TRIOXIDE BY CARBON MONOXIDE. V. G. Vlasov and V. N. Shalaginov. Zhur. Priklad. Khim., 34: 20-7(Jan. 1961). (In Russian)

The kinetics of uranium trioxide reduction by carbon monoxide at 260 to 400°C and 15 to 400 mm pressure indicate a reduction from UO_3 to $UO_{2.92}$ at a rate independent of oxygen elimination. From $UO_{2.92}$ to $UO_{2.55}$ the reduction proceeds autocatalytically, and from $UO_{2.55}$ to $UO_{2.25}$ a new rate constant prevails. From $UO_{2.25}$ to UO_2 the reduction rate decreases with the reduction. The activation energy of the trioxide process is 30.7 kcal/mol; for $UO_{2.55}$ to $UO_{2.25}$, 24.3 kcal/mol. The surface reaction between adsorbed carbon monoxide and oxygen is the determining stage. From $UO_{2.25}$ to UO_2 the reduction is accomplished by diffusion, and oxygen diffusion in the solid phase is the limiting factor. (R.V.J.)

14291 KINETICS OF URANIUM TRIOXIDE REDUCTION BY HYDROGEN. V. N. Strekalovskii and V. G. Vlasov. Zhur. Priklad. Khim., 34: 32-8(Jan. 1961). (In Russian)

The kinetics of UO_3 reduction by hydrogen at 350 to 500°C and 50 to 400 mm pressure exhibit a reduction rate dependent on temperature and pressure. At t = const. the reduction rate is expressed as a function of hydrogen pressure by the equation $v = kp_{H_2}^{1/2}$. The apparent activation energy is 20.8 kcal/mole. A horizontal section appears on the curve of rate dependence on degree of reduction at 400 to 450°C, corresponding to the $UO_{2.6\pm X}$ phase reduction to the tetragonal phase. It is postulated that in the reduction of amorphous UO_3 to U_3O_8 the surface reaction between adsorbed hydrogen and U_3O_8 is the limiting factor. (R.V.J.)

14292 REDUCTION OF URANIUM OXIDE BY HYDROGEN. V. N. Strekalovskii and V. G. Vlasov. Zhur. Priklad. Khim., 34: 38-43(Jan. 1961). (In Russian)

The kinetics of uranium reduction by hydrogen was studied at 450 to 700°C and 20 to 400 mm pressure. It was found that as t ≥ 500°C the phase transformation scheme is: $U_3O_8 \rightarrow UO_{2.6\pm X} \rightarrow U_4O_9 \rightarrow UO_{2+X}$, where X = 0.16 to 0.14. (R.V.J.)

14293 THE CRYSTALLOGRAPHIC INVESTIGATION OF $AuCl \cdot PCl_3$ AND IBOGAINE · HBr. Gerda Johanna Arai-Wessel. Thesis, Leiden, Rijksuniversiteit, 1960. 90p. (In English)

The structure of the two compounds is completely different, one being an inorganic complex and the other being an organic alkaloid complex. The difference in crystal constitution caused a difference in behavior with regard to radiation, requiring the use of specific crystallographic methods for each. Interferences involved in determining their crystal structure are compared and discussed. (N.W.R.)

Radiation Chemistry and Radiochemistry

14294 (AERE-R-3311) FINAL SEPARATION AND PURIFICATION OF GRAM QUANTITIES OF PROTACTINIUM. N. Jackson, F. J. G. Rogers, and J. F. Short (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 9p.

A description is given of the concentration and purification of Pa^{231} obtained from ethereal sludge at Springfields and Windscale. The final amount had an alpha purity of 99.5 ± 0.5% and a chemical purity of 99.7+%. Emission spectroscopy showed that impurities other than Zr and Fe, included Cr, Cs, B, Mg, and Al; alpha pulse analysis revealed an average 7% Pa^{231} daughters present. (B.O.G.)

14295 (NAS-NS-3023) THE RADIOCHEMISTRY OF TIN. W. E. Nervik (Univ. of California). Oct. 10, 1960. 74p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

The radiochemistry of tin is extensively reviewed. The following topics are treated: oxidation states, compounds, spectrophotometry, titration, complexes, extraction, ion exchange, dissolution, and radiochemical and counting methods for determining tin. (195 references) (D.C.L.)

14296 (NAS-NS-3024) THE RADIOCHEMISTRY OF MAGNESIUM. A. W. Fairhall (Univ. of Washington). Jan. 1961. 27p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

A monograph on the radiochemistry of magnesium is presented. The following topics are treated: reviews on the inorganic and analytical chemistry and radiochemistry of magnesium, magnesium isotopes, magnesium salts and complexes, solvent extraction, ion exchange properties, sample dissolution, and counting and radiochemical procedures for magnesium. (D.L.C.)

14297 (NAS-NS-3025) THE RADIOCHEMISTRY OF THE RARE GASES. Floyd F. Momyer, Jr. (Univ. of California). Oct. 1960.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

14298 (NCSC-2477-1) APPLICATIONS OF NUCLEAR RADIATION AND RADIOISOTOPES TO TEXTILE MATERIALS AND PROCESSES. Annual Report, November 1, 1959 to November 1, 1960. Arthur A. Armstrong, Jr. and Henry A. Rutherford (North Carolina State Coll., Raleigh. School of Textiles). Nov. 1, 1960. Contract AT-(40-1)-2477. 72p.

Studies of possible applications of nuclear radiation and radioisotopes to textile materials and processes were undertaken. A broad study was made covering the modification of fibers by exposure to radiation, the modification of fibers by in situ polymerization and/or graft polymerization of vinyl monomers, the application of beta gauges to textile processes, and the use of tracer and activation analysis techniques. Various vinyl monomers were added to textile yarns by gamma radiation using a vapor phase technique. The vapor phase technique was useful only for the volatile monomers acrylonitrile and vinyl acetate at 70°F and one atmosphere pressure. Acrylonitrile and vinyl acetate were readily added to cotton, rayon, acetate, polypropylene, and nylon. Small amounts were added to polyesters and none to acrylics. Activation analysis was proposed for fiber identification and process studies. For fiber identification gamma-ray spectra were presented for most of the commercial textile fibers. A preliminary study was made of fiber blending in the cotton spinning process using activation analysis with manganese as the tracer. (auth)

14299 (TID-11022) TECHNICAL PROGRESS REPORT FOR THE RESEARCH YEAR OCTOBER 1, 1959 TO SEPTEMBER 30, 1960. Contract Year: February 1, 1960 to January 31, 1961. Peter E. Yankwich (Illinois. Univ., Urbana). 30p. Contract AT(11-1)-67.

The effects of isotopic substitution on the rates of a variety of chemical reactions are being studied. While the major part of the work employs the isotopes of carbon, oxygen isotope effects are being investigated in parallel where possible. Experimentation in hot-atom chemistry is designed to permit eventual exposure of the nature and details of processes which take place when an energetic recoil atom is projected into a crystalline matrix, and which determine the ultimate chemical fate of such a particle. Current studies are limited to the reaction $N^{14}(n,p)C^{14}$. The kinetics, mechanism, and isotope effects in several isotope exchange reactions were studied. These include reactions between complexed and uncomplexed ions and gas-solid reactions. Parallel studies were carried out on reactions in which isotope exchange is not involved, such as in the substitution reactions of certain complex ions. (W.L.H.)

14300 (WADD-TR-60-344) A STUDY OF THE NATURE OF FREE RADICALS IN IRRADIATED CHEMICAL SYSTEMS. P. Y. Feng, W. A. Glasson, and S. A. Marshall (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 17, 1960. Contract AF 33(616)-6141. Project No. 7360. 64p.

A study was made of the radiation chemistry of various organic compounds. The compounds studied were chosen to ascertain the effect of structure and presence of functional groups within the basic carbon skeleton on the radiation damaging of the various substrates. Compounds studied were n-, sec-, and tert-butyl iodides, tert-butyl amine, n-butanol, n-butyric acid, and ethyl acetate. The alkyl iodides were studied to ascertain the effect of structural isomerism on a system whose primary dissociative step is known, i.e. carbon-iodine bond fission. The other compounds were studied to evaluate the effect of changing the functional group (alcohol, amine, acid, etc.) and the over-all structure (ester) in a four carbon organic system. The results indicate that over-all yields of products increase on changing from a primary to a secondary to a tertiary bond to the dissociable entity. On changing the functional group the character of the products change as the bond energy in question approaches that of the carbon-hydrogen bond. (auth)

14301 (AEC-tr-4518) EFFECT OF α IRRADIATION OF POLONIUM ON CONCENTRATED SULPHURIC ACID SOLUTIONS. M. V. Vladimorova and Z. V. Ershova. Translated from Radiokhimiya, 2: 495-9(1960). 10p. (Includes original, 5p.).

The radiolysis of concentrated H_2SO_4 solutions by alpha particles from Po^{210} was investigated. It was found that the initial H_2O_2 yield decreases with an increase in the H_2SO_4 concentration. This decrease was due to the reaction of the OH^- radical with an acceptor in a track, as well as to a partial absorption of the irradiation energy of H_2SO_4. A calculation of the energy absorbed by the acid, taking into account the damping capacities, indicated that in 7N H_2SO_4, 23.5% of the total energy is consumed in the acid. A calculation was made of $R\infty/No$, the ratio of the number of OH^- radicals, recombined after an interval of $t - \infty$ to the total number of radicals formed per 100 ev. A decrease in this ratio as a function of acid concentration was found to be in agreement with the diffusion theory. (M.C.G.)

14302 (AEC-tr-4520) "RADIOACTIVE CATALYSTS" DEHYDRATION OF CYCLOHEXANOL ON MAGNESIUM AND SODIUM SULFATES. A. A. Balandin, V. I. Spitsyn, N. P. Dobroselskaya, and I. E. Mikhailenko. Translated from Doklady Akad. Nauk S.S.S.R., 121: 495-8(1958). 8p. (Includes original, 2p.).

The investigation was carried out, using S^{35}-labeled $MgSO_4$ and Na_2SO_4, in a flow-type catalytic apparatus with

n inserted reaction vessel in a horizontal automatic flow-ube furnace, at temperatures of 355 to 415°. The rate of onversion of cyclohexanol was determined by titration, sing the bromine number method of Kauffman. No gaseous roducts nor any radioactive contamination from S^{35} was etected during the process. It was established that the ir-adiation of the catalyst affects the catalytic activity as ell as the activation energy of the process. (B.O.G.)

14303 LIQUID SCINTILLATION COUNTING OF CARBON-14. USE OF ETHANOLAMINE-ETHYLENE LYCOL MONOMETHYL ETHER-TOLUENE. Henry Jef-ay and Julian Alvarez (Univ. of Illinois, Coll. of Medicine, Chicago). Anal. Chem., 33: 612-15(Apr. 1961).

A scintillation method for measuring C^{14} is described. The method consists of the oxidation of an organic com-ound to carbon dioxide and then trapping the gas as the thanolamine carbonate in ethylene glycol monomethyl ther. A portion of the ethanolamine salt solution is trans-erred to a vial containing toluene and the scintillator, and hen counted in a liquid scintillation counter. (auth)

14304 IRRADIATION OF INDUSTRIAL CRACKING CATALYSIS IN A NUCLEAR REACTOR. Philippe Tray-nard and Leon Orsini (Centre d'Etudes Nucléaires, Gre-noble, France). Compt. rend., 252: 873-5(Feb. 6, 1961). (In French)

Two industrial catalysts were irradiated in a reactor, and the catalytic activity of one increased and that of the other decreased. It is shown that the radioactivity is not responsible for this difference in behavior which appears to be caused by the presence or absence of certain ele-ments. (tr-auth)

14305 FORMATION OF AEROSOLS IN THE RADIOLY-SIS OF GASEOUS HYDROCARBONS. V. S. Bogdanov (Zelinskii Inst. of Organic Chemistry, Academy of Sci-ences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 121-4 (Jan. 1, 1961). (In Russian)

The appearance and disintegration of aerosols in gaseous hydrocarbon radiolysis was studied by optical methods and by gravimetric analysis. Irradiation was accomplished by 112-kev electrons. For comparison, studies were made with ethane, propane, n-butane, ethylene, propylene, and methane and oxygen mixtures in a 2-liter brass reactor; with acetylene in an iron reactor; and with ethylene and oxygen mixtures in an aluminum reactor. The results show that considerable amounts of liquid products are formed through the aerosol state. The yields G_a varied depending on the initial hydrocarbon and the quantity of absorbed en-ergy. The highest yield was found with acetylene and the smallest with methane. The yield of aerosol, as a rule, drops with the increase of absorbed energy. Hence, with a 10-fold increase of the irradiation time the aerosol in mix-tures of $C_2H_4 + O_2$ is reduced over 12-fold; with a 3-fold irradiation time increase, the n-butane aerosol yield in-creased 3-fold. The yield of unsaturated hydrocarbons in mixtures of CH_4 and C_2H_4 with O_2 is an order of magnitude higher than the yield of saturated hydrocarbons. However, the maximum yields do not correspond to maximum con-centrations. For acetylene concentrations of 27 mg/l, G_a = 18.7; for propylene concentrations of 40 mg/e, G_a = 7.8. (R.V.J.)

14306 RADIATION OXIDATION OF BENZENE IN AQUEOUS SOLUTION INVESTIGATED WITH THE AID OF LABELED ATOMS. L. I. Kartasheva, Z. S. Bulanovskaya, E. V. Barelko, Ya. M. Varshavskii, and M. A. Proskurnin (Karpov Inst. of Physics and Chemistry, [USSR]). Doklady Akad. Nauk S.S.S.R., 136: 143-6(Jan. 1, 1961). (In Russian)

A benzene-heavy water mixture (26.7 at.% deuterium) was irradiated by Co^{60} γ rays at 170 r/sec for 250 hours. The obtained data confirmed a previous postulation that the products of benzene radio-oxidation in aqueous solution are produced by the recombination of C_6H_7 radicals in $C_6H_6OH^*$ formed as a result of the attachment of hydrogen atoms and OH radicals to benzene molecules. Moreover, the ratio of deuterium concentrations in O=H– and C–H product bonds is about 2:1, confirming that $C_6H_6OD^*$ radicals form about twice as often as $C_6H_6D^*$. (R.V.J.)

14307 THE γ-RADIOLYSIS OF n-HEPTANE AD-SORBED ON OXIDE CATALYSTS. Yu. A. Kolbanovskii, L. S. Polak, and E. B. Shlikhter (Inst. of Petroleum Chemi-cal Synthesis, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 147-50(Jan. 1, 1961). (In Russian)

Radiolysis of adsorbed n-alkanes was studied with n-heptane in aluminum, aluminum–chromium activated by potassium oxide, aluminum–molybdenum, and cobalt–aluminum–molybdenum catalysts. The kinetics of ra-diolysis on the second catalyst was studied at $\theta \leq 1$ and in multilayer adsorption, while in the other catalysts the work was done with monomolecular surface coatings ($\theta = 1$). Heptane adsorption took place at $t \sim 10°C$ and was reversi-ble. It is shown that the catalytic effect depends on the properties of the catalyst. (R.V.J.)

14308 PREPARATION AND TESTING OF LOW-ENERGY RADIATION SOURCES. R. E. Black (General Motors Corp., Warren, Mich.). Intern. J. Appl. Radiation and Isotopes, 10: 30-7(Feb. 1961). (In English)

Low energy radiation sources, to be of value in industrial and medical radiography, must emit essentially no high-energy photons. They must have high specific activity, good mechanical strength, and small physical size. Sources having these characteristics can be made by standard pow-der metallurgical techniques from certain powdered rare-earth oxides and aluminum powder. Tests designed to de-termine mechanical strengths and radioisotope retention abilities of sources of varying compositions formed at various pressures are described and the results reported. (auth)

14309 A COBALT-60 IRRADIATION UNIT FOR RA-DIOCHEMICAL EXPERIMENTS. G. Nagli, U. Prösch, and G. Vormum (Institut für Medizin und Biologie, Deutsche Akademie der Wissenschaften, Berlin). Isotopentechnik, 1: 43-6(Oct. 1960). (In German)

An irradiation unit with a 10-c Co^{60} source is described. Design and operation of the unit are emphasized. Dosage rate and dosage distribution in the irradiation volume were determined by the Fricke dosimeter and by means of glass dosimeters. The maximum dosage rate in the irradiation volume of 40 ml is greater than 10^6 day. (auth)

14310 NUCLEAR RADIATION CHEMISTRY OF OR-GANIC LIQUIDS. D. Bertram. Isotopentechnik, 1: 50-6 (Oct. 1960). (In German)

The paper deals briefly with sources of radiation rele-vant to applied nuclear radiation chemistry, with dosimetric problems, and with primary processes involved with the ef-fect of nuclear radiation on organic substances. In conclu-sion a general view of nuclear radiation chemistry of or-ganic liquids is given in which case less importance is attached to completeness than to the illustration of the pres-ent state of development. (auth)

14311 KINETIC INVESTIGATIONS IN CATALYTIC OXIDATION OF XYLENES BY DEUTERIUM LABELLING. P. Krumbiegel (Institut für Physikalische Stofftrennung, Leipzig). Isotopentechnik, 1: 73-7(Jan. 1961). (In German)

Equipment for measuring the speed of oxidations of xylene isomers is described. Commercial xylene isomers were purified until no foreign matters could be detected in the gas chromatograph and mas spectrum. In addition, o-xylene, m-xylene, oxylene-D_1, and m-xylene-D_6 were synthetized. The dependence of oxidation velocity on some catalysts, on the quantity of catalyst, on xylene concentration, and on the temperature of reaction were determined. (auth)

14312 STUDY BY ELECTRON PARAMAGNETIC RESONANCE OF POLYVINYL CHLORIDE IRRADIATED WITH γ RAYS. R. Gautron, J. Roch, and C. Wippler (Centre de Recherches de la Cie de St. Gobain, Antony (Seine), France and Ecole Normale Superieure de St. Cloud, (Seine-et-Oise) France). J. chim. phys., 58: 159-61(Feb. 1961). (In French)

Electron paramagnetic resonance experiments made on polyvinyl chloride irradiated with γ rays at 77 and 293°K under vacuum give basically different results in the two cases. The chloride irradiated at low temperatures has a 50-gauss ray which is only slightly affected by the action of air, but which disappears when the sample is reheated. No saturation in active centers was observed for doses up to 60 Mrad. The line obtained with polyvinyl chloride irradiated at room temperature is smaller (32 gauss), and its intensity decreases rapidly under the action of oxygen. Above 20 Mrad saturation in active centers is obtained. The phenomena observed can be explained if it is admitted that the centers formed at low temperature are of ions relatively localized and the centers observed at room temperatures are free radicals. (tr-auth)

14313 CONTRIBUTION TO THE STUDY OF GRAFTED COPOLYMERS PREPARED BY RADIOCHEMICAL METHODS. I. GENERAL CONDITIONS OF GRAFTING. SEPARATION AND CHARACTERIZATION OF THE GRAFTED COPOLYMER. Jeanne Sebban-Dannon (Faculté des Sciences, Paris and CNRS, Bellevue, France). J. chim. phys., 58: 246-62(Feb. 1961). (In French)

The radiochemical grafting of styrene on polyisobutylene was studied. A method is proposed for the separation and the analysis of the grafted copolymer obtained. Some of the properties in solution were studied. Two conclusions were reached, one on the structure of the grafted copolymer and the other on the mechanism of the radiolysis of the polyisobutylene in solution in the styrene. It was established that the different samples prepared under the conditions studied have a spreading structure and that the radiolysis of the polyisobutylene leads to the rupture of the lateral chains. A study was made of the modifications — separation into two macrophases and separation into microphases in the place of one of the macrophases. These modifications occur in the reacting medium during the grafting and are the result of the incompatibility of the polymers present. This examination permitted the deduction that the grafting occurs in a precipitating medium. (tr-auth)

14314 CONTRIBUTION TO THE STUDY OF GRAFTED COPOLYMERS PREPARED BY RADIOCHEMICAL METHODS. II. KINETICS OF THE FORMATION OF THE GRAFTED COPOLYMER AND THE HOMOPOLYMER. Jeanne Sebban-Dannon (Faculté des Sciences, Paris and CNRS, Bellevue, France). J. chim. phys., 58: 263-76 (Feb. 1961). (In French)

The study of the radiochemical grafting of styrene on polyisobutylene was continued by examining the effect of factors such as the radiation dose, the radiation intensity, and the initial concentration of the polyisobutylene on the formation of the grafted copolymer and the homopolymer. Although they are produced in the same reacting medium, the reactions of homopolymerization and of grafting have different kinetic characteristics. The classical laws of polymerization are followed by neither reaction. The interpretation of the results observed is based on the fact that the precipitation of the growing chains, resulting from the incompatibility of the polymers present during the grafting, leads to a coalescence or a gel effect according to the conditions. (tr-auth)

14315 CHEMISTRY IN NUCLEAR PROCESSES. I. THE SZILARD-CHALMERS REACTION IN DIBENZENE CHROMIUM (0). F. Baumgärtner (Technische Hochschule, Munich), U. Zahn, and J. Seeholzer. Z. Naturforsch, 15a: 1086-90(Dec. 1960). (In German)

In the (n,γ) reaction in crystalline dibenzene chromium (0) the retention is 11.8%. This value increases to 19.4% if the irradiated sample is sublimated or if it is heated for about 30 minutes to 110°C. It is shown, that the increase of the retention by annealing is not caused only by a reaction of electrons on the skeleton of dibenzene chromium. Besides this, benzene, added as a solvent, cannot replace the recombination-components of Cr^{51} in the post irradiation process. From these facts and from the independence of the annealing effect of the irradiation dose it can be concluded, that the mechanism of the fast annealing is not a recombination of separated fragments, but takes place between reaction components, which are correlated from the very beginning. (auth)

14316 IRRADIATION OF POLYMERS. Solomon Harris Pinner and Arthur Charlesby (to T. I. (Group Services) Ltd.). British Patent 862,505. Mar. 8, 1961.

A method is given for improving the physical properties, particularly at high temperatures, of vinyl chloride polymers and copolymers. In this method, the polymer or copolymer is mixed with 0.05 to 7 times its weight of a finely divided inorganic solid such as carbon black (preferred), silica, or china clay, and the mixture is exposed to ionizing radiation until a total dose of 5 to 25 megarad is received. Other additives may be employed, e.g., plasticizers and antioxidants. (D.L.C.)

14317 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF BRANCHED CHAIN HYDROCARBONS. (to Esso Research and Engineering Co.). British Patent 862,529. Mar. 8, 1961.

A process is given for producing branched-chain homologues and/or isomers from normal paraffinic and isoparaffinic hydrocarbons. This process comprises subjecting the gaseous hydrocarbons or mixtures thereof (containing 3 to 8 and 4 to 8 carbon atoms per molecule for the normal and isoparaffins, respectively) to high-energy ionizing radiation in the presence of ethylene. The radiation dose should be 10^6 to 10^9 kwh per pound hydrocarbon, and the ethylene proportion should be 0.1 to 30 mole %. The net ethylene consumption in the reaction is very low, and ethylene sufficient to induce the reaction can be produced in the hydrocarbons by steam or radiation cracking. A continuous version of the process is given. (D.L.C.)

Raw Materials and Feed Materials

14318 (MCW-1457) RECOVERY OF SCRAP URANIUM METAL BY RECYCLE TO THE GREEN SALT (UF_4)-MAGNESIUM THERMITE BOMB. R. F. Leifield and S. W. Weidman (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Mar. 20, 1961. Contract W-14-108-Eng-8. 27p.

Uranium scrap metal can be recovered on a laboratory scale by recycling to reduction bombs. Scoping experiments indicate that massive pieces of uranium, comprising as much as 7% of the greensalt (UF_4) charge, can be remelted in the 4-kg dingot bomb with no loss of metal quality. Yields, however, decrease because of poor slag-metal separation. An investigation of bomb enthalpies using MgF_2 as a heat sink indicated that the thermite reaction releases sufficient heat to fuse up to 15% of the charge as uranium metal. More extensive experiments demonstrated the acceptability of crude metal yields from 4-kg dingot bombs containing up to 13% (UF_4 basis) of degreased ingot lathe turnings in the charge. However, yields from bombs containing similar amounts of degreased core fabrication turnings were not as high as those attained in normal bombs. Pickling core turnings in nitric acid beforehand improved crude yields to acceptable levels. Pickling dingot turnings improved yields only slightly over the acceptable values for degreased, non-pickled dingot turnings. Metal quality, as measured by density, carbon and nitrogen contamination, and spectrographic analyses, was acceptable for all scrap-recycled bombs. Generally, hydrogen-in-uranium values (for metal produced from charges containing turnings) were higher than baseline values. Dingots produced from charges containing all types of turnings (pickled or non-pickled) contained slag inclusions primarily concentrated at the top. The thickness of the layer increased as the amount of added turnings increased. Metal produced from charges containing degreased, non-pickled core turnings contained slag and oxide inclusions throughout the metal. Cropping losses of metal from the bombs in these studies have been estimated. These data indicate that dingot lathe turnings may be recovered in good yield (>80% recovery of the turnings after cropping) by recycling to the dingot bomb in amounts up to 13% of the UF_4 after only a degreasing step. Core fabrication turnings may be recovered in good yield only when pickled as well as degreased and added to the charge in amounts not exceeding 2% of the UF_4. (auth)

14319 (MITG-416) PROGRESS REPORT ON RAND ORES FOR OCTOBER 16, 1949–NOVEMBER 15, 1949. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Nov. 15, 1949. Decl. Feb. 1, 1961. Contract W-7405-eng-85. 6p.

New residue samples from Blyvooruitzicht and Western Reefs were tested. Low-grade precipitates assaying >9% U_3O_8 were obtained from 396-55 leach liquors neutralized to pH 3.8. The SO_2-air process was modified to produce a solution strong enough for the single-stage leach. Carbonate leaching of precipitate samples from GML requires impractical reagent quantities. (For previous period, see MITG-415.) (auth)

14320 (MITG-419) PROGRESS REPORT ON RAND ORES FOR JANUARY 16, 1950–FEBRUARY 15, 1950. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Feb. 15, 1950. Decl. Feb. 2, 1961. Contract W-7405-Eng-85. 10p.

Excellent results were obtained on anion exchange of Rand leach liquors from leach Process Y, but the results with the less expensive leach Process X are not quite as good. Large cyclic tests were run by the SO_2-air process and various retreatment processes with acceptable results. Additional data were obtained on the uranous phosphates (solubilities in aqueous solutions) and further study was made of mill counting. (For preceding period see MITG-418) (auth)

14321 (MITG-421) PROGRESS REPORT ON RAND ORES FOR MARCH 16, 1950 TO APRIL 15, 1950. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Apr. 15, 1950. Decl. Feb. 1, 1961. Contract W-7405-eng-85. 10p.

Anion exchange resins continue to show promise. Leaching with resin in the pulp increases extraction by 10%. Tests indicate that uranium can be removed from Rand solutions by electrolytic methods. Tests with the copper precipitation method were begun. (auth)

14322 (MITG-A103) SIMULTANEOUS PRECIPITATION OF URANIUM AND COPPER. John J. Brunner (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Oct. 31, 1950. Decl. Feb. 1, 1961. Contract W-7405-eng-85. 40p.

A process for precipitating uranium from Rand leach liquors with metallic iron after addition of phosphate and copper was tested. A series of batch tests and a cyclic test showed that the process can be made to work, that the role of copper is mechanical, that aluminum precipitation is necessary for cyclic operation, and that the precipitate retreatment method can be improved. The optimum conditions for the precipitation of uranium with copper, phosphate, and iron are included. (auth)

14323 (NP-9865) RECENT TECHNICAL DEVELOPMENT IN THE URANIUM REFINING IN JAPAN. Yoshiki Imai (Atomic Fuel Corp., Tokyo). 1960. 29p.

The characteristics, leaching properties, and separation methods used in the milling of the domestic ores are described. The characteristics and record of the Excer process, which was adopted as the refining method, are discussed. The equipment, operation, and results of the reduction of UF_4 with magnesium are described. Improvements in reduction, conversion, and solvent extraction methods are discussed. (B.O.G.)

14324 (NP-9882) MONTHLY REPORT [OF] DEVELOPMENT, JANUARY 1961. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 25p. (D61-1)

A discussion is given of carbonate leach tests on flotation tails prepared from Beaverlodge mill head samples. The caustic precipitation of diuranate from pregnant solutions was investigated. Tests were made to determine the effects of $Ca(OH)_2$ additions and contact time on the bicarbonate and uranium content in a pregnant solution. The influence of process variables and chemical impurities on the decomposition rate of sodium amalgam was studied in a series of compacting tests. Development studies were conducted on NRU and NRX fuel rods. Metallographic studies were made to determine the alloying effects of aluminum and iron on uranium. The results of tests on the reduction of UO_2 with aluminum under cryolite are discussed. Sintering tests were made to determine if UO_2 pellets free of agglomerates and blemishes can be obtained from low-nitrate cast ADU pellets, which were dried, reduced, and granulated. Macrostructures are shown for sintered pellets produced from batch or continuous reduction of ADU. A description is given of two methods used to convert UF_6 to ceramic grade UO_2. (For preceding period see NP-9795.) (B.O.G.)

14325 (TID-11023) PROGRESS REPORT FOR PERIOD COVERING SEPTEMBER 16–NOVEMBER 15, 1960. Henry G. Petrow (Ionics, Inc., Cambridge, Mass.). Nov. 17, 1960. 14p. Contract AT(30-1)-2470.

The analysis of mill solutions for Ra^{224} and Ra^{228} is reported. The application of the radium procedure to urine analysis was investigated, and techniques were developed. The applicability of the thorium procedure to dust-laden filter papers was studied. To evaluate the procedure, filter

paper bearing carnotite of known thorium content was analyzed. A program was initiated to develop a procedure for Ac^{227} analysis. (W.L.H.)

14326 REACTION BETWEEN SOLID UO_2 AND SOLID MnO_2 IN SOLUTIONS OF SULFURIC ACID. E. A. Kanevskii and V. A. Pchelkin. Atomnaya Energ., 10: 138-42(Feb. 1961). (In Russian)

The effects of mixing, ratio of UO_2:MnO_2, concentration of H_2SO_4, preliminary crushing of oxides, and other factors in UO_2 and MnO_2 reactions in sulfuric acid were analyzed in relation to uranium leaching from ores. It is shown that the reaction process takes place at the contact point of UO_2 and MnO_2 hydrate surface layers, the rate of the process being limited by steric hindrance. The importance of iron ions in solid oxidizer (pyrolucite) reaction with the primary uranium minerals in uranium acid leaching from uranium ores is discussed with respect to the above data. (R.V.J.)

14327 A STUDY OF THE BEHAVIOR OF UF_6 IN ORGANIC SOLVENTS. N. P. Galkin, B. N. Sudarikov, V. A. Zaitsev, D. A. Vlasov, and V. G. Kosarev. Atomnaya Energ., 10: 143-8(Feb. 1961). (In Russian)

The solubility and kinetics of UF_6 solution in CCl_4, chloroform, dichloromethane, unsymmetric trichloroethane, symmetric tetrachloroethane, pentachloroethane, trifluorotrichloroethane, symmetric trichloropropane, and tetrachloropropane were studied. It is shown that UF_6 is stable in CCl_4, tetrachloroethane, pentachloroethane and trifluorotrichloroethane during 2 weeks period at 20°C, while at the same temperature UF_6 is not stable in chloroform, dichloroethane, and dichloromethane. It is shown that the UF_6 reactions with the organic solvents at 60 to 100°C first form UF_5 which is reduced to the intermediate uranium fluorides containing a large quantity of tetravalent uranium; then it is reduced to UF_4. (tr-auth)

14328 METHODS OF REDUCING UF_6. N. P. Galkin, B. N. Sudarikov, and V. A. Zaitsev. Atomnaya Energ., 10: 149-55(Feb. 1961). (In Russian)

Various methods of UF_6 reduction to UF_4, suitable for melting reduction, are described. The free energies in UF_6 reduction are quoted. The effects of various factors on the purity and the specific granular weight of UF_4 were analyzed. (tr-auth)

14329 METHOD FOR THE RECOVERY OF URANIUM TRACES. (to Klöckner-Humboldt-Deutz A. G.). German Patent DAS 1 011 371. July 4, 1957. (In German)

A method for the recovery of uranium from secondary minerals is presented. The raw traces are first heated to about 700°C and then tempered in water so that the large grains are separated from the mineral and the fine grains can be further processed for uranium. The heating and subsequent cooling cause the trace scales to flake off the matrix material because of the different heat expansion coefficients. The grains are screened; the large-grain fraction contains half the quartz and very little uranium. The fine grains contain from 80 to 90% of the uranium in the secondary mineral. (J.S.R.)

Separation Processes

14330 (CRCE-980) A MINIATURE EXTRACTION PLANT FOR FUEL PROCESSING. W. G. Mathers, E. E. Winter, R. C. Cairns, L. C. Cornett, and B. M. Mitchell (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1960. 50p. (AECL-1169)

The design and construction of a micro-scale fuel-processing facility were recently completed by the Chemical Engineering Branch of the Chalk River Project. The facility, a two-cycle solvent-extraction process suitable for studying the variables in reactor-fuel processing, was tested inactively, and an active run of 440 hr duration completed. A description of the physical features of the plant, including the extraction equipment, layout, and instrumentation is presented. The operating experience was used in evaluating the equipment performance. (auth)

14331 (BM-RI-5747) EXTRACTION OF ZIRCONIUM FROM NIGERIAN HIGH-HAFNIUM CONCENTRATE. S. L. May, A. W. Henderson, and J. L. Tews (Bureau of Mines, Albany, Oreg.). Aug. 1960. 28p.

Investigations indicated that hafnium and zirconium compounds of acceptable purity can be extracted from Nigerian zircon concentrates. Chlorination and caustic soda fusion techniques were used to extract 85 to 95% of the valuable metals from the concentrate. The extracted hafnium and zirconium compounds were purified by recrystallization of the oxychlorides or by formation of complex salts during chlorination. The zirconium-hafnium product of the recrystallization method contained 15 ppm of uranium. The hafnium was separated from zirconium by solvent extraction methods. A zirconium product containing 0.3% hafnium and a hafnium product containing 4% zirconium were obtained. (auth)

14332 (BNL-5180) THE NITROFLUOR PROCESS STATUS REPORT AND PRELIMINARY APPRAISAL. R. H. Wiswall, Jr., G. Strickland, and F. L. Horn (Brookhaven National Lab., Upton, N. Y.). Jan. 1961. 10p.

The Nitrofluor Process is a method for recovering decontaminated uranium from spent fuel elements. The process involves dissolving the fuel in a mixture of NO_2 and HF; separating impure UF_4 (or UF_5) from the solution; forming UF_6 by treatment with BrF_3; and purifying the UF_6 by fractional distillation. A summary is given of the experimental results, which include discussions on the behavior of various materials in the dissolution step, uranium and plutonium separations, containment, and hazards. An outline is given of the process flowsheet. A preliminary evaluation was made of the economic potential of the process. (B.O.G.)

14333 (HW-66448) UNCLASSIFIED RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT AND THE DIVISION OF RESEARCH, JULY 1960. L. H. McEwen, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 10, 1960. Contract AT-(45-1)-1350. 60p.

Plutonium Recycle Program. Extrusion billets of Pu–Al–Ni alloy were cast and exhibited satisfactory corrosion resistance. Metallographic examinations of Al-Pu rods indicated that very few, if any, microstructural changes occurred in the core due to irradiation. Internal pressures produced at elevated temperatures by gases desorbed from UO_2 contained in PRTR Mark I fuel elements were measured. The applicability of the Magnetic Force Butt Welding Closure Process to materials other than stainless steel and zircaloy was investigated. The erosion effect of stainless steel on zircaloy-2 was determined as a function of temperature in the modified stirring autoclave. The overall PRTR Project was estimated to be about 97.5% complete. Experiments were performed to determine the attack by zirflex decladding solutions on Al–Pu–Ni–Si alloy spike fuel cores. Kinetics of the adsorption of thorium nitrate complex ions on Permutit SK anion exchanger were

tudied. An electrolysis cell sized to permit production of ound lots of UO_2 was placed in operation. Study of non-queous separation processes showed that there appear to e economic prospects for those processes from which ranium of less than natural enrichment can be discarded. Plutonium Ceramics Research. Preliminary investigation f the PuO_2-ZrO_2 phase diagram showed phase boundaries t room temperature equilibrium to be at approximately 0 and 70 wt.% PuO_2. Uranium Dioxide Fuels Research. nalyses of gases released from as-received, fused UO_2 uring vacuum annealing at 800°C indicated approximately ppm of hydrogen and argon. Measurements of thermal onductivity of irradiated UO_2 were resumed. In-Reactor leasurements of Mechanical Properties. Data were ac-umulated on the in-reactor creep rates of a zircaloy-2 pecimen. Activation energies for creep were measured n a series of cold-worked zircaloy-2 specimens at various est temperatures and stress levels. Gas Cooled Power eactor Program. Graphite did not react with high-pres-ure CO_2 in the temperature range 360-660°C during ex-eactor tests for as long as 298 days. Helium density neasurements to determine graphite grain densities are eing made to investigate the possibility that the ultimate ontraction of graphite may not be limited by the theoreti-al density of graphite. Nondestructive Testing Research. A study of the use of orthogonalized exponentials in signal nalysis was continued. Radioactive Residue Processing Development. An experiment was performed in which di-uted high-level Purex waste was passed through three hort columns of clinoptilolite in series. Results indicated cesium capacity of 27 and 35 bed volumes of undiluted vaste. Radiation Effects on Metals. Radiation damage re-overy is being studied for a number of metals. (M.C.G.)

14334 (IDO-14536) STAINLESS STEEL WASTES. II. CO-REMOVAL OF FISSION PRODUCTS IN THE ELECTROLYTIC SEPARATION OF IRON, CHROMIUM, AND NICKEL AT A DROPPING MERCURY ELECTRODE. K. T. Faler and D. R. Anderson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Feb. 16, 1961. Contract AT(10-1)-205. 27p.

A study was made of the removal rates of cesium, barium, strontium, yttrium, cerium, ruthenium, and zirconium as a function of electrode potential at a dropping mercury cathode. Removal was studied in sulfate solutions containing varying concentrations of iron, chromium, nickel, chloride, and acid. Results indicated that iron, chromium, and nickel can be removed from acidic sulfate solutions with good separation from all fission product ions studied except zirconium and possibly ruthenium. Polarographic half-wave potential data were obtained and tabulated together with minimum removal potentials for the fission product ions. A description of the mercury drop-washing polarographic cell used for studying removal of radioisotope tracer amounts is presented. (auth)

14335 (IDO-14540) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER, 1960. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Feb. 15, 1961. Contract AT(10-1)-205. 69p.

ICPP. Liquid wastes in permanent storage were recycled and further concentrated to conserve waste storage space. Ba^{140} production was continued with good recovery of high-quality product. The use of a packed steam stripper to free waste solvent from low concentrations of Pu prior to incineration is discussed. Aqueous Zr Processing. Studies showed that precipitation of barium fluozirconate from dissolver solutions by mixtures of $Ba(OH)_2$ or BaF_2 with $BaNO_3$, rather than with $BaNO_3$ alone, resulted in better Zr separation, lower U loss, and better definition of fission product behavior. Studies of the dissolution of $BeO-UO_2$ fuels in molten ammonium bifluoride demonstrated that a true solution of U is not achieved, but that the dispersion will pass through a 20μ filter and is readily dissolved in HNO_3. It was found that extracted Zr degrades TBP approximately 1000 times faster than extracted HNO_3. A means of criticality control in a non-geometrically safe vessel through uniform interior distribution of neutron absorbing materials was investigated. Waste Calcination. A study was made of the operating characteristics, in a 2-ft square calciner, of one of the feed spray nozzles intended for use in the Demonstrational Waste Calcining Facility. The physical structure of the alumina produced during operation of the fluidized bed calciner has rapidly shifted between an amorphous and a predominantly α-crystalline form. Data indicated that material which is spray dried directly from the nozzle is predominantly amorphous, while that deposited on calcine particles can either remain largely amorphous or be rapidly converted to the α form. The major components of the pilot plant calciner and NaK heater showed little corrosion damage after approximately 6000 hr of service. Optimum ranges of certain reaction conditions were selected for the calcination of fluoride-containing waste solutions: temperature near 500°C, CaO/F equivalency ratio of 0.75 to 1.0, Al concentration above 0.3M, and nitrate concentrations either below 2N or above 3N. Waste Treatment. It was found that an exchange bed of ammonium phosphomolybdate (APM) supported on silica gel shows a decontamination factor of approximately 3000 for Cs^{137} in $Al_2(NO_3)_3-HNO_3$ solutions and a capacity of 35 mg of Cs per gram of APM. It was demonstrated that silica gel could be used to absorb a liquid waste and the waste calcined in situ. Ca and Sr fluozirconates were prepared and their x-ray diffraction patterns determined. In an investigation of the practical aspects of removal, by mecury cathode electrolysis, of Fe, Ni, and Cr from waste solutions, it was demonstrated that up to 3% Fe or Ni could be electrolyzed into the Hg before the amalgam reached a semi-solid state which would require treatment to remove the base metals. A maximum of 0.3% Cr was taken up before electrolysis ceased and a fine black powder separated from the Hg. Electrolytic Dissolution. Electrolytic dissolution in HNO_3 was demonstrated to be applicable to a wide variety of stainless steel and other alloy materials. A search for information on the effect of cell and electrode geometry on electrolytic resistance and current density distributions during electrolytic dissolution was continued. An equation summarizing all the data for the electrolytic dissolution of Zr in HCl–methanol obtained on the potential-current density relationships as functions of temperature and HCl concentration was developed. ARCO Process. Use of HCl as a leaching agent to recover U from the salt matrix in the ARCO process proved unsatisfactory. (M.C.G.)

14336 (MITG-A83) RECOVERY OF URANIUM FROM RAND GOLD ORES. Summary Report [for Period] July 1948–October 1949. John Dasher, R. D. MacDonald, and F. N. Oberg (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Jan. 16, 1950. Decl. Feb. 1, 1961. Contract W-7405-Eng-85. 84p.

Investigations of the extraction of uranium from the Witwatersrand gold ores are summarized. Several tons of these residues were leached countercurrently and the leach solutions precipitated with magnesia or calcined dolomite. The low-grade product (1 to 2% U_3O_8) was retreated by various methods. Single-stage leach processes were developed in which the pulp was neutralized with

limestone to pH 3.5 before filtration. These gave precipitates assaying 3 to 10% U_3O_8 which were easier to retreat. Three feasible and economical retreatment methods were developed: acid digestion-peroxide, carbonate leaching, and ether leaching. Selective precipitation of uranium from reduced leach liquors with $Na_4P_2O_7$ was also demonstrated to be a practical process. The uranium assays required were obtained by fluorimetric methods. (auth)

14337 (MITG-A100) RECOVERY OF URANIUM FROM RAND GOLD ORES. R. D. Macdonald, John J. Brunner, John Dasher, and David Kaufman (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Aug. 1, 1950. Decl. Feb. 1, 1961. Contract W-7405-eng-85. 70p.

Cyanide residue samples from the Blyvooruitzicht and Western Reefs' mills were treated by a single-stage leach to extract uranium. The uranium was recovered by a selective precipitation process involving reduction with iron and the addition of a phosphate and by precipitation with calcined dolomite and retreating the precipitate by the acid digestion-peroxide or the carbonate leaching process. Emphasis was placed on cyclic locked-batch tests and the use of the SO_2-air process for producing leaching reagents. It was found that when Rand leach solutions were passed over strong-base anion exchange resins, uranium was completely and selectively adsorbed. Uranium was taken off the resin with an acidified NH_4Cl solution and precipitated with NH_3. The solution was then acidified with HCl and reused. The total cost of the resin makeup and reagents for elution was only a few cents per pound of uranium. (auth)

14338 (MITG-417) PROGRESS REPORT ON RAND ORES FOR [PERIOD] NOVEMBER 16, 1949–DECEMBER 15, 1949. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Dec. 15, 1949. Decl. Feb. 1, 1961. Contract W-7405-Eng-85. 9p.

Methods for more economical operation of the SO_2-air process were developed, and the process was successfully applied to the Rand leaching problems. Low-grade manganese ore was found to be a suitable source of MnO_2 for use in the leaching process. Lime used to precipitate uranium from leach and carbonate solutions produced a low-grade precipitate from the leach solution but a high-grade precipitate from the carbonate solutions. Acid digestion used with leach process Y gave an indicated overall extraction of only 64%, but this was 88% of the uranium which was extracted by acid leaching. (auth)

14339 (MITG-418) PROGRESS REPORT ON RAND ORES FOR [PERIOD] DECEMBER 16, 1949–JANUARY 15, 1950. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Jan. 15, 1950. Decl. Feb. 1, 1961. Contract W-7405-ENG-85. 9p.

Anion exchange resins removed uranium selectively from both X and Y leach liquors. Cyclic locked-batch tests were run on the new samples using the single leach, the SO_2-air process, and various methods of making a high-grade product. The properties of uranous phosphates were studied, and equipment for continuous counting of mill products was designed. (auth)

14340 (MND-P-2333) SUMMARY REPORT OF AMERICIUM PROCESSING TO BE PERFORMED BY THE MARTIN COMPANY. (Martin Co. Nuclear Div., Baltimore). Mar. 1960. 41p.

Features of the proposed Heavy Element Processing Facility to be constructed near Middle River, Maryland are discussed. The site including location, population density and distribution, meteorology, geology, and hydrology and the facility including the building, support equipment, processing equipment, air handling system, and pre-operational checkout of the facility are described. The physical, chemical, nuclear, and radiobiological properties of Am^{241} are given. The pre-process preparation of americium including receiving, storage, and charging of the process is outlined. Chemical, metallurgical, and decontamination procedures are discussed. Packaging, radiation monitoring, and waste disposal procedures are described. The emergency procedures to be followed for direct external radiation, radioactive spills, air contamination, and fires are reviewed. (M.C.G.)

14341 (TID-7607) PLUTONIUM ION EXCHANGE PROCESSES. Proceedings of the US-UK Technical Exchange Meeting, Oak Ridge National Laboratory, April 25-27, 1960. (Oak Ridge National Lab., Tenn.). 77p.

Nine papers are included which were presented at the meeting in Oak Ridge. The papers are chiefly on plutonium separation by anion and cation exchange, although ion exchange contactors, amine extraction of plutonium, and uranium recovery from reduction residues are briefly treated. Separate abstracts have been prepared for each paper. (D.L.C.)

14342 (TID-7607(p.2-20)) CHEMISTRY OF PLUTONIUM IN ANION EXCHANGE APPLICATIONS. J. L. Ryan (Oak Ridge National Lab., Tenn.).

The chemistry of plutonium in anion exchange systems is reviewed. The effects of temperature and solution concentration on the distribution coefficient of plutonium between Dowex-1 X-4 and $Ca(NO_3)_2$ and HNO_3 solutions are shown graphically. The sorbed species within the resin is $Pu(NO_3)_6^{2-}$. From resin loading rates and stability considerations, it is concluded that 50 to 60°C is the optimum temperature at which to load Dowex and most other strong base resins. The drop in the diffusion coefficient of plutonium with resin loading is believed to be due to water loss by the resin. The effect of uranium on plutonium absorption is also shown. The desorption rates of commercial resins using dilute HNO_3 solutions as eluant are shown. Permutit SK was selected as the best commercial resin for the plutonium nitrate anion exchange process because of its good kinetics at high temperatures and under elution conditions. Data are presented on the separation of plutonium from uranium and metallic impurities using Dowex-1 X-4 and from fission products using Permutit SK. (D.L.C.)

14343 (TID-7607(p.21-33)) CONTINUOUS ANION EXCHANGE PROCESSING OF PLUTONIUM: HANFORD ENGINEERING AND OPERATING EXPERIENCE. W. H. Swift (Oak Ridge National Lab., Tenn.).

The Hanford Purex Plant, whose operation began in 1956 for the solvent extraction of uranium and plutonium, in 1958 substituted continuous anion exchange for plutonium evaporation. Some of the reasons for selecting anion over cation exchange are given. The operation and equipment are described in detail. The ion exchange equipment has a safe geometry with the exception of the XAF tank and the hood floor and sump. The ion exchange system has been operated satisfactorily for >2 yr with decontamination factors for zirconium–niobium on the order of 3 to 5 and losses less than 0.5%. Useful resin life is on the order of 60 to 140 days continuous operation. (D.L.C.)

14344 (TID-7607(p.33-43)) ENGINEERING DEVELOPMENT OF ION EXCHANGE CONTACTORS. A. M. Platt (Oak Ridge National Lab., Tenn.).

The philosophy and some of the objectives of contactor development work at Hanford and the status of this work are discussed. Most of the work was devoted to the me-

anical and hydraulic features of the contactors. Some of e engineering parameters involved in contactor design e given. The following contactor types and their characristics were investigated: moving packed-bed column, oving fluidized bed differential, and moving fluidized ultistage. (D.L.C.)

14345 (TID-7607(p.44-5)) OBJECTIVES OF SAVANAH RIVER PLANT ION EXCHANGE. D. A. Orth (Oak idge National Lab., Tenn.).

Two ion exchange processes are used in the Savannah iver Plant for plutonium separation work: cation exchange or concentration of the Purex 2BP stream and anion exhange for recovery of plutonium from residues. Both are arried out in batches in small fixed resin beds in similar quipment and in a similar "wet cabinet" type installation. he cation exchange system can process solutions with lutonium concentrations as low as 0.001 g/l, and losses re generally low. The anion exchange system, on the other and, is advantageous for recovering plutonium from conentrated acid and salt solutions with high decontamination actors. (D.L.C.)

14346 (TID-7607(p.45-53)) CATION EXCHANGE ROCESS FOR PLUTONIUM. H. J. Groh (Oak Ridge Naional Lab., Tenn.).

The purpose of the cation exchange process used at the avannah River Plant is to concentrate the dilute plutonium olution from the Purex solvent extraction process for subequent processing. A concentration of the order of 50- to 00-fold is accomplished using this process. The process hemistry is described in some detail. The properties of he Dowex cation exchange resins are discussed with respect to requirements for a good cation exchange resin. In he process, plutonium is sorbed in the trivalent state from ilute HNO_3 solution on the resin, uranium and most of irconium–niobium are eluted with dilute H_2SO_4 solution, nd finally plutonium is eluted with strong HNO_3 containing ulfamic acid, yielding a product solution which contains 50 o 60 g/l plutonium. About 20% of the plutonium is left in he bed after the product is cut and ~10% remains as a heel fter the column is reconditioned with dilute HNO_3 containing some reductant. After elution, plutonium(III) is slowly xidized in the product solution. The effects of variables in he elution step on the concentration of plutonium in the eluate are discussed. (D.L.C.)

14347 (TID-7607(p.54-9)) OPERATION OF SAVANNAH RIVER PLANT ION EXCHANGE. D. A. Orth (Oak Ridge National Lab., Tenn.).

The columns used with Dowex-50 cation exchange resin for concentrating Purex 2BP solutions are described. The conditions under which the various processing steps are carried out are given. The behavior of the columns as they age is discussed. The anion exchange recovery of Pu^{4+} from residues is discussed briefly. (D.L.C.)

14348 (TID-7607(p.60-3)) ISOLATION OF PLUTONIUM BY CATION EXCHANGE AT ORNL. R. E. Brooksbank (Oak Ridge National Lab., Tenn.).

A plutonium cation exchange system at the ORNL Metal Recovery Pilot Plant has been operated since Dec. 1953 to concentrate the IIBP plutonium product. The installation is capable of handling 1000 to 1200 g/day plutonium. The columns are maintained at room temperature except during elution and column reconditioning, in which the solutions are cooled to 10°C to prevent gassing in the columns. The resin, Dowex 50-12X, is changed once a year, and plutonium losses to the effluent average ~001%. Decontamination factors for gross β and γ are ~3 and ~5, respectively. (D.L.C.)

14349 (TID-7607(p.64-73)) AMINE EXTRACTION OF PLUTONIUM AND RELATED METALS. C. F. Coleman (Oak Ridge National Lab., Tenn.).

The use of amines to extract plutonium is discussed. Unless the amine concentration is very low, stripping after extraction requires either reduction to plutonium(III) or use of a complexing agent such as sulfate or oxalate. Degradation of the amines due to radiation or chemical effects is not a serious problem because the degradation products are soluble in the aqueous phase ("self-cleaning" effect). The distribution coefficients of several actinides and fission products were determined for solvents typical of primary, secondary, and tertiary amines and quaternary ammonium compounds. Typical solvents available commercially in each class are given. The effects of solution and solvent concentrations and oxidation state on the plutonium and neptunium distribution coefficients were investigated, with the solvent being triisooctylamine in the case of neptunium. (D.L.C.)

14350 (TID-7607(p.74-5)) PRODUCTION EXPERIENCE WITH RECOVERY OF URANIUM FROM REDUCTION RESIDUES BY ANION EXCHANGE IN A HIGGINS CONTRACTOR. N. J. Setter (Oak Ridge National Lab., Tenn.).

The operation of the largest Higgins contactor in use, which was used to separate uranium from reduction residues (chiefly solid MgF_2), is described. The residues were crushed, calcined, and pulverized before being leached with H_2SO_4. MnO_2 was added to oxidize uranium to the hexavalent state. The leach solution was filtered and pumped to the Higgins column using 16-20 mesh Dowex 21K for uranium recovery. The operating conditions used in the column are given. After operation, the resin was passed into a wash section in which water was passed up with a velocity sufficient to remove resin smaller than 20 mesh. The uranium leaving the column was precipitated with NH_4OH and filtered; the filtrate contained 1 to 2 ppm uranium. (D.L.C.)

14351 (TID-11844) THE STUDY OF MASS TRANSFER KINETICS OF URANIUM COMPLEXES. Progress Report No. 1. John B. West (Oklahoma State Univ., Stillwater. School of Chemical Engineering). Jan. 28, 1961. Contract AT(11-1)-846. 12p.

A systematic examination is presented of the mass-transfer rates of uranium in aqueous–organic solvent systems using tributyl phosphate and tri-n-octylamine as the solvents. The effect of salting agents and fission products on the mass-transfer rates of uranium was investigated. The research was divided into two phases: the determination of mass-transfer rates in a steady-flow stirred extraction vessel and the determination of molecular diffusion coefficients of uranium and fission products in aqueous and organic solutions utilizing the capillary-cell technique. (W.L.H.)

14352 (TID-12140) EXPERIMENTAL RESEARCH FOR THE PURIFICATION OF ALKALI HALIDES. Technical Progress Report. Scott Anderson (Anderson Physical Lab., Champaign, Ill.). Feb. 24, 1961. Contract AT(11-1)-544. 29p.

Studies were made on the zone refinement of reagent-grade KCl using a graphite boat. A product containing 5 ppm Ca was obtained. Zone refining using silica vessels was also investigated. Spectrochemical procedures using the cathode layer technique with a conventional arc source were developed for analysis of KCl for ppm concentrations of Al, Ca, Cr, Cu, Fe, Mo, Ni, Pb, V, and Zn, and results are presented for reagent-grade KCl. (D.L.C.)

14353 (TID-12351) SOLVENT EXTRACTION WITH SURFACE-ACTIVE AGENTS. I. QUATERNARY AMMO-

NIUM COMPOUNDS. Arthur M. Wilson, Lillian Churchill, Kenneth Liluk, and Paul Hovsepian (Wayne State Univ., Detroit). [1960]. Contract AT(11-1)-775. 25p.

The solvent extraction of metal ions by a quaternary ammonium halide dissolved in 1,2-dichloroethane is described. The extraction was dependent on the ion association of the quaternary "head" with labeled negatively charged chloro complexes of Fe^{3+}, Co^{2+}, Zn^{2+}, and Ti^{3+} or with the negative oxyanions of Hf^{4+}, Ta^{5+}, and Mo^{6+} in concentrated HCl. The effects of metal ion concentration, contacting time, HCl concentration, and type of quaternary ammonium halide are discussed. Extractions of >50% were possible only if the distribution coefficient, D, of the quaternary compounds themselves was very large. The value of D was found to be dependent on size, shape, and type of organic group attached to the nitrogen. Qualitative agreement of log D vs. molar HCl plots of this solvent extraction system with that of anion exchange chromatography for similar aqueous conditions was found. (auth)

14354 (USNRDL-TR-496) THE COCRYSTALLIZATION OF ULTRAMICRO QUANTITIES OF VARIOUS ELEMENTS WITH ALPHA-NITROSO-BETA-NAPHTHOL DETERMINATION OF URANIUM IN SEAWATER. H. V. Weiss, M. G. Lai, and A. R. Gillespie (Naval Radiological Defense Lab., San Francisco). Dec. 21, 1960. 22p.

The cocrystallization of ultramicro quantities of various elements with alpha-nitroso-beta-naphthol was investigated. Radiotracer techniques were employed to measure the quantitative removal of these elements from aqueous solutions. Conditions were developed for the separation of Ce(III), Zn, Fe(III), Co(II), Zr and U(VI) by this process. Pu(IV) and Ru(III) cocrystallized less completely while Na, Sr, and Sb(III) remained largely associated with the mother liquor. The process was applied in the determination of uranium in seawater. The measured amount was 3.1 ± 0.1 micrograms uranium/liter. (auth)

14355 (AEC-tr-4054(p.389-91)) THE CHROMATOGRAPHIC METHOD OF SEPARATING RADIOACTIVE HAFNIUM AND TANTALUM. N. P. Rudenko and O. M. Kalinkina. Translated from Zhur. Neorg. Khim., 2: No. 4, 959-60(1957).

A chromatographic method was developed for the separation of the radioisotopes of Hf and Ta. Anionite No. 2N-2F was introduced into a water-filled chromatographic column. The height of the packed column was 100 cm. After it was washed with a solution of 9M HCl and 0.5M HF, a portion of the anionite was introduced into the column after absorbing the Hf and Ta from a solution in a mixture of the acids. The elution curve for one separation is shown. (M.C.G.)

14356 (AEC-tr-4054(p.392-405)) THE INFLUENCE OF CERTAIN SALTING-OUT AGENTS ON THE DISTRIBUTION OF URANYL NITRATE BETWEEN AQUEOUS SOLUTIONS AND EXTRACTANTS. S. M. Karpacheva, L. P. Khorkhorina, and G. D. Agashkina. Translated from Zhur. Neorg. Khim., 2: No. 4, 961-9(1957).

Data are presented describing the effect of some salting-out agents on the equilibrium distribution of uranyl nitrate between aqueous solutions and extractants: diethyl and dibutyl ethers and N-butyl acetate. From the curves of the equilibrium distributions obtained, it was possible to compare the extractive capacity of these solvents, and, if necessary, to design the extraction apparatus. By comparing the distribution coefficients of solutions containing various salting-out agents, it was possible to establish a criterion for the evaluation of the effectiveness of salting-out agents, the salting-out equivalent. NH_4NO_3, $NaNO_3$, $Ca(NO_3)_2$, and $Al(NO_3)_3$ were used as the salting-out agents. (M.C.G.)

14357 (AEC-tr-4056(p.363-72)) SOME DATA ON THE EXTRACTIVE PROPERTIES OF TRIBUTYL PHOSPHATE (TBP). S. M. Karpacheva, L. P. Khorkhorina, and A. M. Rozen. Translated from Zhur. Neorg. Khim., 2: No. 6, 1441-7(1957).

An investigation was made of the extractive properties of tributyl phosphate in mixtures of two diluents; dibutyl ether and kerosene. The capacity of the solvent for uranyl nitrate calculated for pure TBP was ~400 g/l or ~1.7 mol/l and was independent of the concentration and nature of the diluents investigated. The distribution of nitric acid at a TBP concentration in diluent of 20, 40, and 100% was measured. The capacity of the solvents was greater at higher concentrations, confirming the formation of a monosolvate, and reached approximately 1.2 mol HNO_3 per mol of TBP. In the presence of nitric acid, the capacity of the solvent for uranyl nitrate practically reached the value corresponding to the formation of the disolvate. (M.C.G.)

14358 (DEG-Inf.Ser.-16) THE SEPARATION OF FLUORIDE IONS BY MEANS OF ION EXCHANGE RESINS. W. Funasaka, M. Kawane, T. Kojima, and Y. Matsuda. Translated by S. G. Brickley from Bunseki Kagaku, 4: 514-17(1955). 9p.

Separation of F^- from disturbing ions by use of anion exchange resin was attempted. A strongly basic ion exchange resin (OH-type) is used for absorption of F^- and disturbing ions, the F^- is liberated by treating it with 0.1N NaOH, leaving the other disturbing ions in the resin. Necessary procedures of the method are given. (auth)

14359 THE CHEMICAL AND ENGINEERING BASIS OF THE REPROCESSING PLANT IN MOL (BELGIUM) AND ITS LAYOUT. Hans Gotte (Farbwerke Hoechst A. G., Frankfurt am Main and Universität, Frankfurt am Main). Atom u. Strom, 6: 103-7(Dec. 1960). (In German)

The aim of fuel element reprocessing is both the separation of the fuel and breeder materials from each other and also from fission products and the restoration of both these materials to a chemical form suitable for the production of new fuel elements. How these problems were solved in the reprocessing plant at Mol is reported in detail. (tr-auth)

14360 GAS-SOLID REACTIONS: APPLICATIONS IN URANIUM PROCESSING. A. R. Cooper and J. E. Lloyd (United Kingdom Atomic Energy Authority, Preston, Eng.). Chem. Eng. Sci., 14: 353-66(Jan. 1961).

The reactions $UO_3 + H_2 \rightarrow UO_2 + H_2O$, $UO_2 + 4HF \rightarrow UF_4 + 2H_2O$ are important steps in the production of uranium metal and uranium hexafluoride. The rate of these reactions has been shown to be determined by the structure of the solid surface which in turn is modified by the progress of the reactions. The thermal damage phenomena which have been observed are of greater significance in this type of heterogeneous reaction than in the more general fields of combustion and catalysis. They influence the choice, design and operation of an "ideal" reactor system for the production of UF_4; these aspects of the chemical engineering of the "Dryway" reactions are discussed. (auth)

14361 RECOVERING URANIUM FROM GRAPHITE FUEL ELEMENTS. Mildred J. Bradley and Leslie M. Ferris (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., 53: No. 4, 279-81(Apr. 1961).

A method for the recovery of uranium from high-density, graphitized uranium-graphite fuel elements was developed on a laboratory scale as a head-end treatment for tributyl phosphate solvent extraction processes. Simultaneous disintegration and leaching of the uranium occur when the fuel is contacted with 90% HNO_3, either at room temperature or at the boiling point. More than 99.8% uranium was recovered

vhen the fuel contained at least 5% (weight) uranium, but nly 97% was recovered from fuel containing 0.7% (weight). Alternative techniques involve disintegration with bromine, Cl, or IBr prior to leaching with boiling 15.8M HNO_3. After romine disintegration, 96 and 99.8% of the uranium were recovered from fuels containing 0.7 and 9% (weight) uranium, respectively. Both ICl and IBr were better disintegrating agents than bromine; however, uranium recovery fter ICl disintegration was lower. (auth)

4362 CONTINUOUS SCHEME FOR SEPARATING NIOBIUM AND TANTALUM BY CYCLOHEXANONE EXTRACTION. Ya. G. Goroshchenko, A. G. Babkin, V. G. Mairov, and S. A. Fedyushkina. Zhur. Priklad. Khim., 34: 43-9(Jan. 1961). (In Russian)

A continuous, closed-cycle, scheme for preparing pentoxides of niobium and tantalum by cyclohexanone extraction from sulfuric acid solutions was achieved. Separation rom the organic phase is achieved by fluorination by ndustrial ammonium, sodium fluoride, or hydrofluoric cid. The scheme may be utilized as a direct continuation of a sulfuric acid scheme for treating titanium-niobium oncentrates. (R.V.J.)

14363 REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 4, No. 1. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Jan. 1961. 64p.

Reviews are given of the following: the commercial aspects of fuel processing; safety in chemical processing; preparation for fuel processing; research and development on fuel processing; waste disposal; and the production of plutonium, thorium, uranium, and their compounds. (B.O.G.)

14364 PERMSELECTIVE MEMBRANES. Arthur Charlesby and Solomon Harris Pinner (to T. I. (Group Services) Ltd.). British Patent 860,405. Feb. 1, 1961.

A method is given for manufacturing permselective membranes which are strong and chemically inert and have high exchange capacity and high electric conductivity in the swollen state. In this method, a polymer film is formed and then exposed to high-energy ionizing radiation which crosslinks the film to render it insoluble in water or aqueous solutions. The polymer is made either from a substituted olefin in which one of the substituents is an ionic group, or from a nonionic monomer or polymer which is polymerized or crosslinked by irradiation to form a polymer into which ionic groups are introduced. The membrane may be deposited onto a porous substrate for both support and greater electric conductivity. A continuous variation of the method is given. (D.L.C.)

14365 PURIFICATION OF THORIUM OR URANIUM, OR THORIUM–URANIUM ALLOYS. (to U. S. Atomic Energy Commission). British Patent 862,860. Mar. 15, 1961.

An electrolytic method is given for purifying irradiated thorium, uranium, and thorium–uranium alloys. In this method, an electrolytic cell is used in which the cathode is composed of one or more of the metals Zn, Cd, Sn, Pb, Sb, and Bi in the molten form and the electrolyte is a fused salt containing a salt of thorium and/or uranium. The thorium and/or uranium that is deposited at the molten cathode forms an alloy therein, from which it is separated easily by volatilization of the cathode metal. In the preferred version of the method, both the cathode and anode are composed of the same molten metal, preferably zinc, with the anode covering completely the impure thorium and/or uranium so that the more noble impurities are retained in the anode while the thorium and/or uranium are electrolytically transferred to the cathode. The method has the advantages of economic feasibility, simplicity, and recovered metal purity. (D.L.C.)

14366 METHOD FOR THE REDUCTION OF PLUTONIUM AND ITS APPLICATION IN SEPARATING PLUTONIUM FROM URANIUM. (to Commissariat à l'Energie Atomique). French Patent 1.220.061. Jan. 4, 1960.

Plutonium(IV) ions can be reduced in an acid medium to Pu(III) ions by means of ascorbic acid. For separating plutonium from uranium, a nitric acid solution of Pu(IV) ions and U(IV) ions in tributyl phosphate is extracted with an aqueous ascorbic acid solution; Pu(III) ions are transferred to the aqueous phase. (NPO)

14367 METHOD FOR OBTAINING HIGHLY CONCENTRATED PLUTONIUM. K. Diebner. French Patent 1.226.416. Feb. 29, 1960.

Plutonium or U^{233} is obtained in a relatively high concentration by removing the surface layer of neutron-irradiated U^{238} or Th^{232} fuel elements. (NPO)

14368 METHOD FOR REGENERATING FUEL ELEMENTS. (to U. S. Atomic Energy Commission). French Patent 1.227.096. Feb. 29, 1960.

Neutron-irradiated U–Al or Pu–Al fuel alloys are regenerated by means of an electrolytic method in which the molten alloy is utilized as the anode, graphite or aluminum as the cathode, and molten cryolite as the electrolyte. (NPO)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

14369 (AERE-R-3252) REMOTE-HANDLING AND ANALYTICAL TECHNIQUES USED IN THE PROCESSING OF SAMPLES FROM H.T.G.C. LOOP IRRADIATIONS. P. E. Brown, R. H. Flowers, and D. F. M. Lupton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 18p.

Details are given of a high level radiochemical cell which was in use for over a year without presenting any major difficulties. Some useful devices and techniques are described in connection with the radiochemical analysis of multi-curie level samples from H.T.G.C loop experiments. (auth)

14370 (HW-59843) DEVELOPMENT AND PRELIMINARY TESTING OF POWDER-LOCK FEEDER. J. Dunn (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 3, 1959. Contract AT(45-1)-1350. 7p.

Studies of a system for controlling plutonium powder transfer were undertaken. Details are given of equipment designed to fulfill the requirements and of proposed equipment for installation on additional Hot Button Line prototypes. The rotary powder-lock feeder developed at HAPO proved to be completely satisfactory in preliminary tests using lead oxide (commercial litharge) as a stand-in for plutonium oxide. Approximately 150 lbs of lead oxide were passed through the lock at controlled rates varying from 2.2 to 44 cu in./min (3 to 60 rpm). The pressure differential maintained between inlet and discharge was 57 in. of water as compared to the expected plant requirement of 10 in. of water. The initial powder lock used to demonstrate the basic lock concept was fabricated from stainless steel and employed Teflon ring gaskets. To permit its use in chloride atmospheres some parts of the valve must be changed to corrosion resistant materials. The Teflon gaskets are considered suitable for powder lock temperatures up to 375°C. For temperatures above that new gasket materials and arrangements should be provided and tested. (auth)

14371 (JPL-TR-32-32) ULTRA-HIGH-FREQUENCY OXIDE INDUCTION-HEATING FURNACE. Martin H. Leipold and Jack L. Taylor (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Mar. 17, 1961. Contract NASw-6. 4p.

A method is presented by which a furnace chamber may be heated to temperatures in excess of 2200°C in air. The method offers the advantages of quiescent atmosphere, temperature stability, and control of heating and cooling rates from room temperature to maximum operating temperature. The furnace employs ultra-high-frequency induction heating of poorly conducting ceramic rings. The rings are preheated to conduction temperatures by means of small resistively heated wire elements which are withdrawn prior to application of high-frequency power. The suscepting elements themselves consist of yttrium oxide stabilized ZrO_2, while the thermal insulator is composed of unstabilized ZrO_2 grain. Details and modifications to the control systems for the preheating and high-frequency heating systems are given. The furnace provides a chamber 2 in. in diameter and 4 in. long, operating to a maximum temperature of 2350°C with excellent control and highly efficient power input to the work. The unit should find application in fabrication of oxides and in testing properties of materials in air at high temperatures. (auth)

14372 (SCTM-406-60(73)) RAILROAD TRANSPORTATION SHOCK AND VIBRATION TESTING. P. H. Adams (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 18p.

A description is given of a test made to determine how successfully precision equipment can withstand transportation environments and to obtain data on this environment. (auth)

14373 (TID-12269) RESULTS AND ANALYSIS OF ROOM TEMPERATURE PRESSURE TESTING OF THE HOWARD FOUNDRY PESCO PUMP VOLUTE S-2463-1 PWA # 248773. J. M. Dufford, R. R. McMath, and H. West (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Jan. 3, 1957. 30p. (TIM-370)

Results are presented for room-temperature pressure tests run on a Pesco pump volute. In the tests, strain gages were positioned at a number of points around the volute to obtain the complete stress distribution. The results indicate that the maximum stresses occur in the small section of the volute rather than in the large section. (D.L.C.)

14374 THE DEVELOPMENT AND APPLICATION OF GAS TURBINES IN SOUTH AFRICA WITH SPECIAL REFERENCE TO COAL AND NUCLEAR FUELS. W. L. Grant and A. J. A. Roux (South African Council for Scientific and Industrial Research, Pretoria). Ind. Rev. Africa. Suppl. Atomics and Energy, 2: No. 1-2, 3-23(July-Aug. 1959). (AEB-1) (In English)

Aspects of gas turbine development with emphasis on applications in South Africa are discussed. A review of developmental work in various parts of the world on coal burning turbines is presented and local efforts on conventional combustion chambers and resonant combustion systems are outlined. The possible applications of gas turbines to nuclear reactors in South Africa are also examined. (J.R.D.)

14375 NEW RESULTS IN THE RANGE OF THE ULTRA-HIGH VACUUM. Ch. Kleint (Karl-Marx-Universität, Leipzig). Exptl. Tech. Physik, 8: 193-210(1960). (In German)

Vacuums above 10^{-11} Torr are considered. The calculation of the pump process, construction materials and measurement methods, and some observations in ultrahigh vacuum in connection with investigations of field emission are reviewed. 24 references. (J.S.R.)

14376 RADIO-TRACER TECHNIQUES FOR THE STUDY OF FLOW IN SATURATED POROUS MATERIALS. H. E. Skibitzke, H. T. Chapman, G. M. Robinson, and R. A. McCullough (U. S. Geological Survey, Phoenix, Ariz.). Intern. J. Appl. Radiation and Isotopes, 10: 38-46(Feb. 1961). (In English)

An experiment was conducted to determine the feasibility of using a radioactive substance as a tracer in the study of microscopic flow in a saturated porous solid. A radioactive tracer was chosen in preference to dye or other chemical in order to eliminate effects of the tracer itself on the flow

tem such as those relating to density, viscosity, and face tension. The porous solid was artificial sandstone nposed of uniform fine grains of sand bonded together n an epoxy adhesive. The sides of the block thus made re sealed with an epoxy coating compound to insure ter-tightness. Because of the chemical inertness of the ck it was possible to use P^{32}. Ion-exchange equilibrium created between the block and nonradioactive phos-ric acid. Then a tracer tagged with P^{32} was injected into block in the desired geometric configuration, in this e, a line source. After equilibrium in isotopic exchange reached between the block and the line source, the ck was rinsed, drained, and sawed into slices. It was nd that a quantitative analysis of the flow system may be de by assaying the dissected block. (auth)

377 BRAKE SYSTEM WITH PROGRESSIVE ACTION FOR A FREELY FALLING BODY. (to Commissariat a l'Energie Atomique). French Patent 1,217,172. y 2, 1960.

For stopping the fall of a body, e.g., of a safety rod in a clear reactor, the rod is suspended by a cable wound on drum provided with a braking device. The drum has a rizontal axis and the cable lies on the drum in a heli-dal groove; the drum moves in axial direction during rotation, so that the free part of the cable undergoes sideward movement. As a result of its axial movement drum front comes into frictional contact with a brake c. By the action of the drum this brake disc also under-es an axial movement, against the force of a spring. To ng about the axial movement of the drum a threaded inder connected to it is screwed by its rotation into a pport piece. (NPO)

378 CHEMICAL PROCESSING VESSEL. (to United gdom Atomic Energy Authority). French Patent 22.135. Jan. 18, 1960.

A vessel is described for dissolving irradiated fuels. The sel consists of a vertical cylindrical container, which is vided at the bottom and top side with a steam jacket and ooling jacket respectively, and a separate vertical plate-ped container. Suitably placed conduits enable the sol-t to circulate by convection through both containers. All ensions are such that critical conditions cannot be es-lished. (NPO)

eat Transfer and Fluid Flow

379 (AFOSR-TN-60-813) ASYMPTOTIC FORM OF UILIBRIUM DISTRIBUTION FUNCTIONS IN A FLUID D PROPERTIES OF LOCAL-EQUILIBRIUM ENSEMES. J. L. Lebowitz (Yeshiva Univ., New York) and K. Percus (New York Univ., New York. Inst. of Mathetical Sciences). [1960?]. 30p.

The asymptotic form, i.e., the (1/N) dependence, is obned of the joint distribution of (q + l) molecules when the of q molecules is very far from the set of l in an equirium fluid consisting of N molecules in volume V. The mptotic form is used to determine the low-order disbution functions for an equilibrium system of varying sity, as well as for a nonequilibrium system repreted by a local equilibrium ensemble. The distribution ctions are shown to be governed by the temperature and sity in the vicinity of the molecules considered. It is nd that the two-body distribution function coincides, to hin quadratic terms in the gradients, with its equilib-m value for a uniform system at the temperature and sity of the midpoint. For the higher order distributions, rrection terms are found to be linear in the gradients. th)

14380 (CF-57-3-95) MEASUREMENT OF THE FRICTION CHARACTERISTICS FOR FLOW IN THE ART FUEL-TO-NaK HEAT EXCHANGER. S. I. Cohen and T. N. Jones (Oak Ridge National Lab., Tenn.). Mar. 19, 1957. Decl. Sept. 15, 1959. 11p.

The friction characteristics of a full-scale straight-tube model of the ART fuel-to-NaK heat exchanger were determined. The presence of the spacers resulted in a transition to semi-turbulent flow at a Reynolds modulus of 350. The semi-turbulent flow persisted up to a Reynolds modulus of 5,000. Over the major part of this region ($500 < N_{Re} < 3,000$), the friction factor can be specified by the equation, $f = 5.7/N_{Re}^{0.56}$. The circumferential spacers were found to contribute slightly more than the radial spacers to the pressure loss in the heat exchanger. (auth)

14381 (HW-40388(Excerpt)) TRANSIENT FLOW OF STEAM-WATER MIXTURES. Excerpt from: WATER WALL RUPTURE IN A HIGH PRESSURE REACTOR—HYDRAULIC AND HEAT TRANSFER EFFECTS. F. E. Tippets (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 12, 1955. 17p.

An equation of motion was derived for a non-ideal compressible fluid in a duct having finite discontinuities in flow geometry; the equation is being used in the analysis of problems involving transient flow and heat transfer in steam-water mixtures. To facilitate the computations and still obtain conservative results it was assumed that the expansion in the rear water wall and piping would be isentropic. The determination of the critical mass velocity of a fluid flowing in a duct is discussed. Transient heat conduction calculations are described for the fuel elements which would give the least allowable time before emergency cooling would have to be re-established. The procedure is given for calculating approximately the requirements for re-establishing the coolant flow, which must be established through the tubes within 28 sec after the front wall rupture. (B.O.G.)

14382 (NAA-SR-5661) EXPERIMENTAL EVALUATION OF A SODIUM-TO-SODIUM HELIFLOW HEAT EXCHANGER AT TEMPERATURES UP TO 1200°F. J. S. McDonald (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 28, 1961. 41p. Contract AT-11-1-GEN-8.

A 100-kw model heliflow-type intermediate heat exchanger was subjected to steady state and transient tests with sodium at temperatures of 1200°F. Using multiple correlation techniques, functional relationships were obtained which described steady state behavior of the model. The general performance characteristics were found, by effectiveness comparisons, to be between those of pure counterflow and multipass overall counterflow. The unit was found to be relatively safe from structural damage from rapid thermal transients. (B.O.G.)

14383 (NAA-SR-Memo-1328) HEAT TRANSFER ANALYSIS AND DESIGN OF A PLUGGING INDICATOR SYSTEM FOR SRE. H. L. Sletten (North American Aviation, Inc., Downey, Calif.). Apr. 1, 1955. 15p.

The analysis was performed on a system comprising a counterflow, concentric-pipe economizer, heat exchanger, flowmeter, plug, and connecting pipe. The system was assumed to be at some initial temperature equal to the inlet sodium temperature and suddenly loses heat to a medium in the heat exchanger. Design and operating data are presented. A cooling rate curve is given where the nitrogen flow rate is decreased when the plug temperature reaches 400°F. The time variation of minimum temperatures is given for various values of thermal capacitance with constant equilibrium temperature, and the economizer

parameter with constant equilibrium temperatures and thermal capacitance. The variation in heat exchanger parameter with economizer parameter for a constant equilibrium minimum temperature of 250°F, and a constant inlet temperature of 750°F is indicated. (B.O.G.)

14384 (NYO-9372) THE NUMERICAL SOLUTION OF A PARABOLIC SYSTEM OF DIFFERENTIAL EQUATIONS ARISING IN SHALLOW WATER THEORY. Jack Heller and Eugene Isaacson (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Oct. 15, 1960. 21p.

A finite difference approximation to a nonlinear set of parabolic differential equations arising in shallow water theory is given. These difference equations were used to determine the shape and rate of propagation of a hump of fluid down a channel of constant depth. The hump of fluid was found to spread instead of steepen, as in the case in the usual shallow water theory. (auth)

14385 (ORNL-3067) SUPERPOSITION OF FORCED AND DIFFUSIVE FLOW IN A LARGE-PORE GRAPHITE. R. B. Evans, III, J. Truitt, and G. M. Watson (Oak Ridge National Lab., Tenn.). Mar. 10, 1961. Contract W-7405-eng-26. 64p.

An experimental investigation of steady-state counterflow of gases in a large-pore graphite was carried out using an AGOT graphite septum exposed to sweep streams of helium and argon. The total pressures of the experiments ranged from 1.2 to 6 atmospheres; the temperatures were 24 to 27 and 100°C. Forced flow experiments, from which permeability constants were obtained, revealed that Knudsen effects were small and that the turbulent flow region would be encountered at low flow rates. The results of uniform-pressure diffusion experiments, which led to a mutual-diffusion coefficient for the gas mixture, indicated that a normal diffusion mechanism was controlling and verified the existence of a net drift under these conditions. Comparisons of data from combined forced and diffusive flow experiments with predicted values demonstrated that reasonable estimates of the combined flow could be made utilizing the data obtained in separate experiments. (auth)

14386 (SB-450) HEAT TRANSFER AND HEAT EXCHANGERS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Jan. 1961. 33p.

A bibliography is presented on 575 reports which were listed in U.S. Research Reports and Technical Translations. (D.L.C.)

14387 (TID-11921) PRESSURE LOSSES WITHIN DUCTING SYSTEMS AND COMPONENTS FOR INCOMPRESSIBLE FLOW. R. T. Cliffe, F. O. Drummond, F. S. Faron, D. P. Flitner, P. V. Folchi, and D. L. Jones (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 5, 1959. 51p. (DC-59-1-156)

A collection of pertinent charts and formulas for the evaluation of pressure drops in duct systems having isothermal "incompressible" flow is presented. Most of the common duct components were considered, including valves, diffusers, and sections of irregular construction. Pressure loss factors and friction factors for varying relative roughness and Reynolds number are given. Formulas for calculating pressure drops in straight ducts of various cross sections are presented. Pressure drop relations for duct fittings and connections, turning vane information, a sample problem, a basic comparison between compressible and incompressible flow, and a discussion of the application of a curved duct relationship to the solution of a wavy plate pressure drop problem are included. (M.C.G.)

14388 (TID-12146) BASIC EXPERIMENTAL STUDIES ON BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES FOR MONTH OF FEBRUARY 1961. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). Feb. 28, 1961. Contract AT(30-3)-187. 34p. (MPR-X-2-61)

An outline is given of the test program for the developme of tube test sections. Analytical work on burnout detector fluctuations are summarized as a statistical approach to interpreting the repetitive occurrence of fluctuations and a method of using the duration of a fluctuation for estimating a maximum possible surface temperature transient. (B.O.C

14389 (TID-12255) FORCED CONVECTION LIQUID METAL INPILE LOOP WATER PRESSURE DROP AND HEAT TRANSFER COEFFICIENTS. E. J. Dypa and W. Ackermann (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 30, 1959. 30p. (TIM-487)

Pressure drops and flow rates were measured in the reactor process system in the C66-J13 facility of the Engineering Test Reactor adjacent to the forced-convection liquid-metal in-pile loop. Local heat transfer coefficients were calculated for certain areas where heat is transferred to the water. The water pressure drop and flow rate were found to be 55 psi and 223 gpm, respectively, almost identical with those in the reactor core itself, and jacket wall temperature analysis showed that at no point is it high enough to boil the water or to damage the jacket. (D.L.C.)

14390 (TID-12256) EXPERIMENTAL DETERMINATION OF HEAD LOSS COEFFICIENTS FOR STRUT-FRAME-TYPE HEAT-EXCHANGER-TUBE SUPPORTS. Lee K. Knudsen (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 6, 1959. 38p. (TIM-583)

Strut-type heat-exchanger-tube spacers were tested under flow conditions covering Reynolds numbers between 2×10^4 and 1.2×10^5. The strut-frame spacers, 0.036-in. thick, supported and spaced in triangular fashion 0.250-in. diam. tubes on 0.330-in. centers. Head losses for these strut-frames are presented as plots of velocity head loss coefficient vs Reynolds number. (auth)

14391 (TID-12266) FORCED CONVECTION LIQUID METAL INPILE LOOP PUMP PERFORMANCE CHARACTERISTICS. C. R. Nelson (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Mar. 24, 1959. 25p. (TIM-476

Data are presented on the performance of a liquid metal pump for use with a forced-convection liquid-metal in-pile loop in the C-66 J-13 core test facility of the Engineering Test Reactor. The data are based on water tests run with two prototype stainless steel impellers for various axial clearances between the impeller discharge face and the diffuser for a constant radial clearance between the labyrinth seals and the transition block. It is concluded that the pump will produce the required head and flow rate and will perform satisfactorily at both room temperature and the design operating temperature. (D.L.C.)

14392 (TID-12310) RESEARCH ON HEAT TRANSFER TO FLUIDS FLOWING THROUGH NON-CIRCULAR CHANNELS. Progress Report, September 1960–March 1961. E. R. G. Eckert and J. L. Novotny (Minnesota. Univ., Minneapolis. Heat Transfer Lab.). Mar. 1961. Contract AT(11-1)-659. 12p.

Turbulent heat transfer was measured in rectangular ducts of aspect ratio 1:1 having a thermal boundary condition of two vertical walls approximating an adiabatic boundary and two horizontal walls approximating a constant heat

ux boundary. Measurements were made to determine the ow Reynolds number limit, the bulk temperature rise consistent with constant property assumption and structural mitations, and the heat transfer coefficient as a function f distance along the axis of the duct. The centerline temerature distribution of the heated walls for a heat transfer un with a bulk temperature rise of 61.8°F. The Nusselt umber was calculated from the fully developed heat transer coefficient, the hydraulic diameter, and the thermal onductivity based on the average bulk temperature for the uct. Heat transfer for flow in rectangular ducts was also alculated for the following boundary conditions: constant all temperature peripherally with constant axial heat flux nd constant axial and peripheral heat flux. The calculaions were carried out by use of the Deissler method. M.C.G.)

4393 (WADD-TN-59-424(Pt.II)) PRELIMINARY ANALYSIS OF THE CAPABILITIES OF A COMPOSITE LAB FOR AN ADVANCED HEAT-SINK DESIGN. Paul A. ibby (Brooklyn. Polytechnic Inst.). June 13, 1960. Contract AF33(616)-5944. 52p.

The results of a numerical analysis of the capability of a omposite slab of BeO and Be to absorb the heating associted with the re-entry of a high performance ballistic misile are presented. The trajectory considered corresponds o a ballistic factor (W/CDA) equal to 2000 psf, to a rentry velocity of 20,000 fps, and to a re-entry angle of 20°. he numerical results indicated that the maximum permisible heat transfer rates for the trajectory are obtained ith a relatively thin slab of beryllium oxide. The addition f beryllium to this slab may be required for structural and hermal shock considerations but does not greatly improve he heat-sink capabilities. The permissible values of the eat transfer parameter were applied to a slender cone ith a 20° half angle and with a spherical cap of 0.25 ft nose adius. It is shown that for laminar flow no heat transfer eduction is required on the cone while for turbulent flow a eduction to 1/2 is required. Various means for achieving eat reduction are discussed. (auth)

4394 FORCED CONVECTION EFFECTS ON BOILNG HEAT TRANSFER. Stanley B. Koehler. Argonne atl. Lab. News-Bull., 2: No. 2, 7-9(Mar. 1961).

Convection effects were studied in nucleate, transition, nd film boiling. Organic liquids in a low pressure system ere used since their peak boiling flux is $1/10$ to $1/5$ that of ater. Tests show that the surface temperature in a nulear reactor will surge from a peak nucleate value to a uch higher one in film boiling at a slightly higher heat ux. When decreasing the flux below the minimum point, ne temperature will drop suddenly and low nucleate boilng will occur. An expression was developed to correlate rced-convection peak nucleate boiling. (N.W.R.)

4395 THE HEAT CONDUCTING PROBLEM IN THE UBE SHEET OF A HEAT EXCHANGER. THE APPLICAION OF A MODIFIED FINITE HANKEL TRANSFORMAION. W. Kattwinkel (L. & C. Steinmüller, Gummersbach/ hld., Ger.). Atomkernenergie, 6: 15-18(Jan. 1961). (In erman)

With respect to thermal stress the temperature distribuion in the tube sheet of a heat exchanger is investigated. he corresponding boundary value problem in steady state onditions is solved by means of a modified finite Hankel ansformation. A numerical example is given. (auth)

4396 DESIGN OF HEAT EXCHANGERS FOR NUCLEAR POWER PLANTS. PART II. B. F. Ridal and J. H. Vilson (Simon-Carves, Ltd., Cheadle Heath, Stockport, hes., Eng.). Chem. & Process Eng., 42: 125-9(Mar. 1961).

Consideration of heat exchanger design for nuclear power plants is continued by an analysis of fin efficiency. The problem of economic design is treated thoroughly and the various factors in the cost of steam-raising units are classified. Flow-induced vibrations are discussed, and methods are suggested for avoiding this hazard. (N.W.R.)

14397 TRANSIENT BEHAVIOUR OF COUNTERFLOW HEAT EXCHANGERS. PART II. F. L. Carvalho (Babcock and Wilcox Ltd.). Chem. & Process Eng., 42: 130-5(Mar. 1961).

An example illustrating a method of solving the temperature–time history of two fluids passing through a heat exchanger is shown in order to compare theoretical results with experimental data. Good agreement was found between the two, proving that the method is a useful means of quickly assessing unsteady performance in heat exchangers. (N.W.R.)

14398 FORMAL HEAT TRANSFER SOLUTIONS. C. F. Bonilla (Columbia Univ., New York), J. S. Busch, H. G. Landau, and L. L. Lynn. Nuclear Sci. and Eng., 9: 323-31 (Mar. 1961).

Three solutions to three different cases of transient heat transfer in a conduit cooled on the inside by a flowing coolant are presented. The heat transfer mechanism is described by a pair of coupled partial differential equations applicable to nuclear reactor design and analysis. The first solution is for the case of coolant flowing at constant velocity through a conduit with internal heat generation a function of distance. The heat transfer coefficient from conduit to coolant is infinite for transfer so that the conduit and coolant temperatures are always equal. The coolant inlet temperature varies with time. All physical properties of the coolant and conduit are taken as constant. Four specific sets of conditions are considered. In the second case the coolant inlet temperature is constant, the heat transfer coefficient is infinite, the internal heat generation is a function of distance, and the coolant velocity decreases with time, as on loss of pumping power. Three specific sets of conditions are considered. The third case is the same problem as case one except that the heat transfer coefficient between the conduit and coolant is finite. (auth)

14399 VELOCITY MEASUREMENTS OF WATER IN A CLOSED LOOP WITH A COBALT-60 RADIATION CAPSULE. C. E. Moeller, Charles W. Stanley, and W. E. Snyder (Midwest Research Inst., Kansas City, Mo.). Rev. Sci. Instr., 32: 207-9(Feb. 1961).

The velocity of water in a closed loop was measured using a Co^{60} source placed in a capsule of such density that it would circulate with the water without causing an appreciable resistance to flow. The specific density of the capsule was adjusted to design value by the addition of water through a small fill hole in one end. In tests carried out over a range of pressures, two capsules were used simultaneously. These circulated independently, one at a lower pressure and the other at a higher pressure. A set of 19 records taken under identical conditions gave an average velocity in the downcomer of 0.81 ft/sec, a maximum velocity of 0.90 ft/sec, and a minimum of 0.77 ft/sec. (M.C.G.)

14400 RADIATION PYROMETRY AND ITS UNDERLYING PRINCIPLES OF RADIANT HEAT TRANSFER. Thomas R. Harrison. New York, John Wiley & Sons, Inc., 1960. 244p. $12.00.

A unified discussion of the laws of emission, absorption, reflection, and transmission of thermal radiation is presented which is applicable to radiant heat transfer as well as to radiation pyrometry. The characteristics of radiation pyrometers are described and analyzed mathematically,

and the application of emittance corrections is discussed. Tables are included showing radiation pyrometer calibrations, optical characteristics of various substances, some radiation functions, and mathematical relationships useful in radiation pyrometry. (D.L.C.)

14401 IMPROVEMENT IN HEAT EXCHANGE BY FLUIDS WHICH CIRCULATE IN A CLOSED CYCLE, IN PARTICULAR IN NUCLEAR POWER PLANTS. (to Société Française des Constructions Babcock and Wilcox, and Marcel Veron). French Patent 1.184.469. Feb. 2, 1959.

A fluid in which a reversible reaction can take place, such that the reaction is endothermic when the fluid is heated and exothermic when it is cooled, is proposed for utilization as the primary coolant in a nuclear reactor. The sole example given of such a fluid is PCl_5. The reaction $PCl_5 \rightarrow PCl_3 + Cl_2 - 30$ kcal is practically complete at 300°C (temperature of the reactor core) while the reverse association reaction is practically complete at 130°C (temperature in the heat exchanger). These fluids increase the heat transfer and reduce the heat-exchanger surface. (NPO)

14402 IMPROVEMENTS RELATING TO THE PRODUCTION AND UTILISATION OF HEAT. (to Societe Francaise des Constructions Babcock and Wilcox). French Patent 1,214,344. Apr. 7, 1960.

In order to control the entrance temperature in a gas cooled nuclear reactor, the mode of circulation of the hot gas through the heat exchanger can be varied by diverting the gas from at least a part of the heat exchanger elements. This diversion is effected by valve means situated inside the heat exchanger or boiler and operated from the outside. The boiler has an outer casing with circular cross section and, preferably, has an inner casing with rectangular cross section; the diverting conduits are arranged inside the segmentary interspace between the two casings, each of these conduits being provided with valve means. The heat exchanger elements from which the gas may be diverted are suitably constituted by the superheater elements. (NPO)

Instrumentation

14403 (AERE-M-475) THE PULSED DIRECT CURRENT AMPLIFIER: A METHOD OF OPERATING TRANSISTORS AT VERY LOW CURRENTS. E. H. Cooke-Yarborough (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1959. 7p.

A pulsed d-c amplifier is proposed from considerations for estimating the drifts occurring in the first stage of the amplifier. The drifts relate to the changes of current or voltage necessary to the first stage input terminal to cancel the drifts and so to keep constant the current or voltage fed from the first stage to the second. The improvement obtained by pulsing is greater than the smplification by a single transistor stage. The low current drift obtainable in pulsed d-c amplifiers should allow usage in precise pulse rate meters and pulse integrators. (B.O.G.)

14404 (AERE-M-794) GAS GAIN DRIFT IN A GAS FLOW X-RAY PROPORTIONAL COUNTER; A METHOD OF STABILISATION. C. E. Mellish and J. A. Payne (United Kingdom Atomic Energy Authority. Research Group. Wantage Radiation Lab., Harwell, Berks, England). Dec. 1960. 9p.

Descriptions are given of the counter and the means for measuring the gain in the counter. Results are given for experiments to determine the variations of gain with pressure and temperature. The principles used for stabilizing the gain of the counter are discussed. The stabilized counter was found to produce a change in gain of ~3% when heated to 40 to 50°C, whereas in an unstabilized system the gain approximately doubles for this temperature change. (B.O.G.)

14405 (AERE-R-3291) AN AUTOMATIC 1000 CHANNEL READ-OUT SYSTEM. R. L. Elliott (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 1960. 27p.

Equipment was designed using standard relays and uniselectors to transfer digital information, originally stored on a ferrite matrix, from transistor trigger circuits on to perforated paper tape. The keynote of the design was reliability, accuracy, reasonable speed, and adequate life. Experience suggests that these were achieved to a satisfactory degree. (auth)

14406 (AERE-R-3422) A MAGNETIC TAPE RECORDING SYSTEM FOR NUCLEAR PHYSICS RESEARCH. I. N. Hooton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1960. 34p.

A magnetic tape recording system using $\frac{1}{4}$-inch tape and storing up to 38 bits of correlated digital information per external event is described. The system is extremely flexible and provides for sorting signals on replay. Novel circuits for eliminating the effects of drop outs are incorporated. (auth)

14407 (AFOSR-364) INSTRUMENT TO MEASURE DENSITY PROFILES BEHIND SHOCK WAVES. W. J. Witteman (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Feb. 1961. Contract AF49(638)-401. 18p. (BN-232)

An optical method for the quantitative study of the density distribution behind shock waves was developed. The method, which uses a photo-electric recording, is based upon the integrated Schlieren method originally devised by Resler and Scheibe. A detailed theoretical analysis is given. Excellent agreement with predicted performance was found in measurements of the density profile behind shock waves in CO_2. The method was found to be very accurate and to retain its high sensitivity for weak shocks. The pictures obtained showed a nearly exponential approach to equilibrium of the density behind shock waves. (auth)

14408 (BM-RI-5738) HIGH-TEMPERATURE FURNACES FOR X-RAY DIFFRACTOMETERS. William J. Campbell, Stephan Stecura, and Clark Grain (Bureau of Mines, College Park, Md.). Feb. 1960. 30p.

Developments in the field of high-temperature x-ray diffractometers are summarized through 1959. Various furnace designs are evaluated, and the x-ray diffraction facilities of the Federal Bureau of Mines are described briefly. For furnaces having precise sample movements, x-ray optics are equivalent in resolution and line profile to conventional x-ray techniques; however, there is an intensity loss due to x-ray absorption in the furnace windows and a reduction of useful angular range. In oxidizing atmospheres, temperatures up to 1500°C were obtained with furnaces wound with Pt–20% Rh wire, while under non-oxidizing conditions, temperatures of 1800 to 2000°C were obtained with Ta foil and W wire heaters. Accurate temperature measurement in the samples is the most difficult problem in high-temperature x-ray diffractometry. A probable error of ±10 to 20°C is estimated for temperature determinations at 1000°C, the error increasing with temperature. (53 references). (D.L.C.)

4409 (CEA-1705) TRANSISTORIZED WIDE BAND ULSE AMPLIFIER. J. Girard, Y. Hazoni, and H. Savinelli France. Commissariat a l'Energie Atomique. Centre Études Nucléaires, Saclay). 1960. 8p.

A simple wide band amplifier is described. It has a stability better than 0.001 deg^{-1} centigrade, a current gain of 10^3, bandwidth of 30 MHz, and a signal-to-noise current ratio of about 100. This amplifier was studied to answer the need of a fast transitor head amplifier for nuclear detectors with pile up and overloading problems. (auth)

4410 (CNEN-6) CATENA ELETTRONICA RAPIDA ER MISURE IN FISICA NUCLEARE. (Fast Pulse Analyzing and Counting System for Measurements in Nuclear Physics). M. Maccioni, C. Pedicino, U. Pellegrini, B. Risoli, and A. Serra (Italy. Comitato Nazionale per l'Energia Nucleari, Ispra). Oct. 1960. 52p.

The "fast pulse analyzing and counting system" designed with adjustable elements to be used in experiments of nuclear physics requiring a high resolving power is described. The electronic system designed for a particular experiment is also briefly described. (auth)

4411 (HASL-110) A TRANSISTORIZED LOGARITHMIC COUNT RATEMETER, HASL TYPE TR-1. R. T. Graveson (New York Operations Office. Health and Safety Lab., AEC). Mar. 1961. 15p.

A four-decade, log-count ratemeter based on a three-diode pump section is described. The design equations for the system are included. All circuits are constructed on etched circuit boards to facilitate testing, construction, and servicing. (auth)

4412 (HW-65553) TRANSISTORIZED LINE-OPERATED RADIATION DETECTION INSTRUMENTATION. W. G. Spear (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1961. Contract AT(45-1)-1350. 44p.

Count-rate-meter type instruments employing transistorized, interchangeable modular circuits were developed for use with various detectors, e.g., GM tubes, BF_3 tubes, proportional detectors, and scintillators. Three instruments are described in particular: aural alpha-beta-gamma monitor, scintillation plus air-proportional alpha monitor, and model II Scintran monitor. (D.L.C.)

4413 (HW-65919) HANFORD CONTROLLED POTENTIAL COULOMETER. R. E. Connally and F. A. Scott (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 11, 1960. Contract AT(45-1)-1350. 8p.

A controlled-potential coulometer for determining the amount of a reducible ionic species in solution is designed which is capable of a potential control of ± 10 mv and determination of 1 to 100 microequivalents of the sample. The coulometer, a modification of that made by Kelley, Jones, and Fisher, uses analog computer amplifiers to control the titration potential and to integrate the cell current. (D.L.C.)

14414 (JINR-P-510) O REGISTRATSII β-CHASTITS S POMOSHCH'YU KREMNIEVYKH n-p PEREKHODOV. (Alpha-particle Counting with Silicon n-p Transitions). B. M. Golovii, B. P. Osipenko, and A. I. Sidorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1960. 15p.

The application of semiconductors as solid state α-particle detectors is reviewed. Experiments using p-type silicon junctions with 50 ohm-cm resistivity, produced by diffusing phosphorus, are described. The thickness of the sensitive layer obtained was 15 to 20 microns, and the area of the counter 20 mm^2. Characteristic bias curves were measured, as well as the response to Pu^{239} α-particles. It was found that with increasing bias the pulse-height does not depend strongly on the resistance. The mechanism by which the pulses are produced is examined and some formulas for calculation of pulse-height and rise time are given. (T.T.T.)

14415 (NAA-SR-Memo-1624) CALIBRATION OF 1 cm^2 GOLD FOILS WITH ORNL STANDARD GRAPHITE PILE. R. L. Koontz, R. S. Hart, and J. H. Strong (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 17, 1956. 6p.

A combination of 1 cm^2 gold foils and a counter was calibrated so that they could be used to measure absolute thermal neutron fluxes. Both bare and cadmium-shielded gold foils were irradiated in the ORNL standard graphite pile for periods of one week each. The counting instruments used were three gas-flow 2π proportional units. Each counter was checked daily against a standard RaD + E source. The calculated saturation counting rate based on the average values from the three instruments is given. (M.C.G.)

14416 (NARF-60-20T) A NEW LOW-FREQUENCY AMPLIFIER WITH RADIATION-TOLERANT PROPERTIES. A. M. Morgan Voyce (Convair, Fort Worth, Tex.). Dec. 30, 1960. Contract AF33(600)-38946. 26p. (MR-N-257)

A low-frequency, high-input-impedance preamplifier was developed for use in nuclear environments. The prototype models are designed to accept sine-wave inputs of from 5 to 50,000 cps from piezo-electric transducers and transmit them over cables up to 500 feet long. The amplifiers were operated to design specifications before, during, and after irradiation to an exposure of 5.7×10^{14} neutrons/cm^2 (>2.9 Mev) and 4×10^7r gammas. (auth)

14417 (NP-9929) A NOTE ON THE OPERATION OF THE NRC HIGH-SPEED CAMERA. Suffield Technical Note No. 51. F. L. McCallum and J. C. Muirhead (Canada. Suffield Experimental Station, Ralston, Alberta). Jan. 16, 1961. 10p.

The use of the NRC high-speed camera and some modifications made on it are described. Modifications were made in the alternator drive, methods of measuring the framing rate, electrical and oil line connections, and focusing. The operational procedure and its adaptation to shock-tube work are discussed. (M.C.G.)

14418 (NRL-5587) READOUT CONTROL UNIT FOR AUTOMATIC TYPE-PUNCH SYSTEMS. J. W. Butler (Naval Research Lab., Washington, D. C.). Feb. 13, 1961. 21p.

The design and construction of a control unit for automatically transferring data from the memory of a 256-channel pulse-height analyzer to an automatic type-punch system are described. The data are then available in both printed and punched-tape form. The punched tape is coded for the Narec (the Naval Research Laboratory computer) and can be fed directly into the Narec without further processing. The hexadecimal system is used, but the control unit can be adapted for use with the decimal system and for almost any type of computer. On the particular control unit described here, a single switch provides for alternate use of the Royal McBee LGP-30 code. Provision is also made for the simultaneous operation of a chart recorder so that all three methods of data recording—printing, punching, and plotting—may be performed concurrently. The system described has a wide range of applicability. It can be adapted to any source of information in binary form and to any recording equipment which can utilize binary information in the form of relay closures. (auth)

14419 (SB-435) SEMICONDUCTORS (SUPPLEMENT TO CTR-340). OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Sept. 1960. 20p.

A bibliography is presented covering PB reports, AEC reports, and translations added to the OTS collection during the period April 1950 to October 1960 on semiconductors. (T.R.H.)

14420 (SC-4464(RR)) DESIGN AND CONSTRUCTION OF A UNIT FOR MEASURING METAL SKIN TEMPERATURES. (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Feb. 1961. For Sandia Corp. Purchase Order 52-4823. 54p.

Research is directed toward theoretical evaluation and experimental development of special thermocouples capable of being accurately located at or near the surface of metal structures to permit measurement of temperature distribution through the structures. Reliable positioning of thermocouples in steel bodies was achieved using a clamping procedure to prevent shifting of the wires during the welding process. To permit evaluation of the performance of embedded thermocouples under high rates of heat input, an electrical heating device was developed, consisting of a molybdenum filament held between two heavy copper buss clamps, insulated with mica, and sandwiched between two sections of the structure containing the embedded thermocouples. At a heat rate of 0.805×10^6 Btu/hr-ft^2, the experimental surface temperatures agreed with theoretical surface temperatures within ±3% or better. Weld-nugget-embedded thermocouples were evaluated, with agreement between theoretical and experimental values again being of the order of ±3% or better. The surface-temperature instrumentation for a Mach-5 tail fin consisted of six surface thermocouples placed along various chordal sections of the fin. The thermocouples consisted of plugs containing nickel wire insulated with a thin coating of ceramic and placed normal to the heated surface, the junction being formed by polishing off the plug and wire extending beyond the fin surface and electroplating a thin layer of nickel. Experimental evaluation of thermocouples in a simulated tail fin indicated that they are capable of providing a valid record of the surface-temperature history. (auth)

14421 (SCTM-369-60(24)) SYSTEMS UTILIZATION OF INCREMENTAL MAGNETIC TAPE RECORDING AND MOTION. Edward C. Dowling (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 46p.

Considerations are given for the utilization of an incremental magnetic tape digital recording machine in the AIDS data complex. The design of the machine is largely controlled by the associated compatibility desired machines. Thus, great detail is covered in the elemental parameters of compatibility. From these elements, the options of design are illustrated and specific directions recommended. Included in the over-all considerations are those of data compatibility, economics, complexity, and relative values. (auth)

14422 (SCTM-431-60(24)) INITIAL PEAK SURGE CURRENT DETECTION CIRCUITS. Milo M. Conrad (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 17p.

Test requirements for several components specifies that surge currents be monitored to determine if the initial peak surge current exceeds a certain predetermined amplitude. Two circuits which were developed to meet this requirement in production testing are described and evaluated. (auth)

14423 (TID-3907) BIBLIOGRAPHY ON SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. J. L. Blankenship, comp. (Oak Ridge National Lab., Tenn.). Dec. 6, 1960. 16p.

The bibliography (150 references) is an outgrowth of the research on semiconductor detectors at the Oak Ridge National Laboratory. (W.L.H.)

14424 (TID-7594) PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. (Oak Ridge National Lab., Tenn.). 253p.

The papers presented at the Gatlinburg symposium are compiled. The papers treat the application of very large scintillators, particularly sodium iodide crystals for gamma-ray spectroscopy. Separate abstracts have been prepared for 19 of the papers, while 5 have been previously abstracted in Nuclear Science Abstracts. (D.L.C.)

14425 (TID-7594(Paper 1)) RESOLUTION OF TOTAL ABSORPTION NaI(Tl) CRYSTALS. Edward H. Brooks and William L. Weiss (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Paper 1 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.1-23.

Two large NaI(Tl) crystals were found to differ considerably in the energy resolution exhibited. The resolution of a 5-in. diam. × 8-in. long crystal with a single 5-in. diam. phototube was found to be 14.0% at 0.662 Mev using a collimated beam of gamma photons from a Cs^{137} source. A second crystal 8-in. diam. × 8-in. long, using three 3-in. diam. phototubes, was found to have an energy resolution of 9.7% at 0.662 Mev with a Cs^{137} source at 50 cm uncollimated. Improvement of the resolution is discussed. (auth)

14426 (TID-7594(Paper 2)) AN EVALUATION OF TWO 4″ × 4″ NaI(Tl) DETECTORS USED FOR LOW LEVEL ENVIRONMENTAL SAMPLES. B. M. Branson, G. J. Karches, and G. I. Coats (Robert A. Taft Sanitary Engineering Center, Cincinnati). Paper 2 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.24-9.

Methods of improving resolution, efficiency, and background for the 4 × 4-in. NaI(Tl) crystal detectors are described. A comparison of two systems is made. The first detector assembly employs a 5-in. photomultiplier and the second uses a de-based 3-in. tube. Both units are shielded by 6-in. of steel, but the second assembly has a ⅛-in. lead liner under a steel liner. (auth)

14427 (TID-7594(Paper 3)) TRANSFER VARIANCE REDUCTION IN HIGH ENERGY GAMMA RAY SPECTROMETERS. William W. Managan (Argonne National Lab., Ill.). Paper 3 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.30-40.

For high-energy gamma rays in a total absorption gamma ray spectrometer, the number of photoelectrons per event is large enough that the variance in this number does not control the line width. Using a light pipe to distribute the photons more uniformly over the photocathode will reduce the line width. The total light transferred to the photocathode is reduced, but the line width is significantly improved. Using a 4 in. diam. by 4 in. long NaI(Tl) scintillator mounted on a Type 6364 DuMont 5 in. diam. photomultiplier, it was found that a full diameter light pipe 25 to 50% of the crystal length eliminates most of the effect due to the photocathode nonuniformity. The particular 6364 used showed 2.5 to 1 sensitivity variations, which is typical of the few tested. This result seems to apply for gamma ray energies above 1 Mev. At some energy below 1 Mev, the number of photo-

ctrons per event will become few enough that the variance his number will begin to increase the line width. (auth)

128 (TID-7594(Paper 4)) DESIGN, CONSTRUCTION, D PERFORMANCE OF LARGE NaI(Tl) CRYSTALS. C. Stewart, R. Carlson, and C. Schmidt (Harshaw Chemi- Co., Cleveland). Paper 4 of PROCEEDINGS OF THE TAL ABSORPTION GAMMA-RAY SPECTROMETRY MPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 0. p.41-7.

Large NaI(Tl) crystals used as total absorption gamma spectrometers are improved in energy resolution by ter optical design and new mounting techniques. Detector stems composed of two large crystals optically coupled l viewed by the same set of photomultiplier tubes are cussed. Pulse height resolution as a function of energy given for a 9 in. × 12 in. composite NaI crystal. The lat- crystal is made from a 9 in. × 7 in. and a 9 in. × 5 in. stal viewed by six 3 in. photomultiplier tubes. (auth)

429 (TID-7594(Paper 6)) AN ANTICOINCIDENCE M SPECTROMETER COMBINING SODIUM IODIDE AND ASTIC SCINTILLATORS AND A SUM COINCIDENCE ECTROMETER UTILIZING TWO SODIUM IODIDE CRYS- ALS. William H. Ellett (Massachusetts. General Hospital, ston). Paper 6 of PROCEEDINGS OF THE TOTAL AB- RPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, ATLINBURG, TENNESSEE, MAY 10-11, 1960. p.60-70.

A description of a total absorption gamma ray spectrom- er utilizing a 5 in. diam. × 5½ in. NaI crystal and an 18 × 18 in. plastic anticoincidence mantle is presented. eoretical and experimental data on the efficiency of the C mantle in detecting escape radiation and the effect of the C mantle on the background counting rate of the NaI crys- l are discussed. The performance of this spectrometer is mpared to that of a system utilizing two solid 3 in. × 3 in. aI crystals in a "sum coincidence" arrangement which duces the number of recorded Compton interactions in scade events to a negligible portion of the total spectrum. uth)

4430 (TID-7594(Paper 7)) TOTAL ABSORPTION NTICOINCIDENCE SPECTROMETER. C. O. Bostrom and E. Draper (Yale Univ., New Haven). Paper 7 of PRO- EEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY PECTROMETRY SYMPOSIUM, GATLINBURG, TENNES- EE, MAY 10-11, 1960. p.71-9.

A total absorption anticoincidence NaI(Tl) spectrometer as used to measure gamma-ray spectra from thermal eutron capture in a variety of elements. The spectra in- lude those of H, Be, B, Cl, Fe, Ni, Hg, and Pb. Examples f these spectra are presented as well as analysis of the nergy dependence of efficiency, resolution, and line shapes. uth)

4431 (TID-7594(Paper 9)) THE EFFECTS OF SCIN- TILLATOR DIMENSIONS UPON PULSE-HEIGHT SPECTRA STIMATED BY MONTE CARLO FOR LARGE NaI CRYS- ALS. R. W. Peelle (Oak Ridge National Lab., Tenn.). aper 9 of PROCEEDINGS OF THE TOTAL ABSORPTION AMMA-RAY SPECTROMETRY SYMPOSIUM, GATLIN- BURG, TENNESSEE, MAY 10-11, 1960. p.89-96.

For some idealized cases in which a collimated mono- nergetic gamma-ray beam enters each crystal along its xis, results from the Monte Carlo program of Zerby and Moran are utilized to illustrate the dependence of calculated ulse-height spectra on the size and shape of large NaI scin- illators. Effects of materials around the crystal are not considered. Most cases were calculated for an incident hoton energy of 2.75 Mev, and size variations were taken bout a nominal right circular, cylindrical crystal 9 in. in diameter by 10 in. long. Under these conditions, the results indicate that at 2.75 Mev the use of a scintillator with a truncated conical end has some effect on the portion of the spectrum near full energy if the crystal length is held constant, that a re-entrant cavity at the point of entry of the gamma rays greatly reduces the escape of low-energy radiation through the crystal face, that the crystal diameter affects predominantly the high-energy portion of the spectrum, and that the crystal length controls the low-energy portion of the spectrum. (auth)

14432 (TID-7594(Paper 10)) TOTAL-ABSORPTION PEAK EFFICIENCY FOR LARGE CRYSTAL NaI SCINTILLATION SPECTROMETERS. W. E. Kreger and R. M. Brown (Naval Radiological Defense Lab., San Francisco). Paper 10 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.97-104.

Measurements of the pulse-height spectra obtained from large crystal NaI(Tl) scintillation spectrometers exposed to monoenergetic gamma rays were used to determine the total absorption peak to total spectrum ratio for the crystals. The crystals used in this experiment were a 4-in.-diam. by 4-in.-long NaI crystal, a 5-in.-diam. by 6-in.-long NaI crystal with a ¾-in.-diam. by 1½-in.-deep well drilled in the end, and a 9-in.-diam. by 9-in.-long crystal with a similar well drilled in the end. The crystals were mounted in lead shields which had ½-in.-diam. collimating apertures concentric with the crystal axes. The collimating aperture allowed the monoenergetic gamma rays to impinge on the front surface of the crystal or at the bottom of the well in the two larger crystals. The values of peak to total ratios obtained were fitted to an empirical relationship over the energy range involved with three parameters as the fitting variables. Some phenomena involving nonsymmetrical and double total absorption peaks were also determined. (auth)

14433 (TID-7594(Paper 11)) GAMMA-RAY RESPONSE MEASUREMENTS OF LARGE NaI(Tl) CRYSTALS. T. A. Love and G. T. Chapman (Oak Ridge National Lab., Tenn.). Paper 11 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.105-12.

The variation in response of a large NaI(Tl) crystal to monoenergetic gamma rays is shown for two geometric crystal configurations. The configurations are a right cylinder 8 in. in diameter and 8 in. long and a cylinder 9⅜ in. in diameter and 5¾ in. long with a conical end 3½ in. long truncated at a 2-in. diameter on the small end. A comparison is made of the experimental response from a right cylinder crystal constructed from two pieces of NaI(Tl), each 8 in. in diameter and 4 in. long, with the calculated response which should be expected from a solid 8 × 8-in. right cylinder crystal. The results show that a useful large crystal can be constructed by joining two smaller crystals. (auth)

14434 (TID-7594(Paper 13)) TOTAL ABSORPTION SPECTROMETER FOR 1-10 Mev GAMMA RAYS. William W. Managan (Argonne National Lab., Ill.). Paper 13 of PROCEEDINGS OF THE TOTAL ABSORPTION OF GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.120-30.

A large NaI(Tl) scintillator was designed for high detection efficiency and total energy absorption of gamma rays which result from neutron capture in time-of-flight experiments. The crystal size, 8 in. in diameter by 6 in. long, was based on a Monte Carlo type calculation, which showed it was unnecessary to use a larger crystal in order to absorb all of the gamma-ray energy in most of the cases.

Difficulties reported with such large crystals appear, at least partly, to result from poor optical transfer of photons from the scintillator into the photomultiplier. Therefore a large photomultiplier (EMI-9545) was chosen to provide a photocathode diameter equal to that of the scintillator. The total number of photons per gamma ray being large, a lucite light pipe 8 in. in diameter by 1½ in. thick was used. Normal spectra without "double peaks" were obtained with this design. The relative line width (full width at half maximum) is 9.3% for 0.662-Mev gamma rays from Cs^{137}. Gamma rays of 4.43 Mev from a Pu-Be neutron source gave a relative line width of 4.5% and a peak to valley ratio of five to one. The one-escape peak was lower than the total absorption peak. The two-escape peak was negligible. (auth)

14435 (TID-7594(Paper 14)) LIQUID XENON SCINTILLATION STUDIES. Paper 14 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.131-9.

Liquid xenon offers promise as a total absorption γ-ray spectrometer because of its high density, its high degree of uniformity, and the low neutron cross sections of certain Xe isotopes. A small liquid xenon counter was constructed from a quartz ampule containing ~2 cm^3 of liquid xenon and was viewed by a μ-v sensitive photomultiplier, K 1306. With diphenyl–stilbene wave-length shifter on the inside of the ampule, pulse heights for γ rays were ½ of those observed with a commercially canned NaI(Tl) crystal. The mean decay time of scintillation events in purified liquid xenon due to γ rays from Cs^{137} was 50 and 22 mμsec for α particles. Decay times in gaseous xenon were observed to be strongly dependent on impurities. An attempt to measure the self-absorption of the primary scintillation light in liquid xenon, within the ampule dimensions of ~1 cm, permitted setting a lower limit to the mean free path of 15 cm for light having wave lengths above about 2000A. (auth)

14436 (TID-7594(Paper 15)) PRELIMINARY STUDIES OF COMPUTER PROCESSING OF GAMMA SPECTRA. R. O. Chester (Oak Ridge National Lab., Tenn.). Paper 15 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.140-6.

A method of automatically processing gamma spectra is being developed. The method used presupposes nothing about the spectrum to be analyzed. Semiempirical functions are used to fit system response to monoenergetic gamma input. Simple power function fits, as a function of energy, to the parameters of the response function are used to develop the response matrix. (auth)

14437 (TID-7594(Paper 16)) DATA PROCESSING TECHNIQUES FOR ROUTINE APPLICATION OF GAMMA-RAY SCINTILLATION SPECTROMETRY. R. L. Heath (Phillips Petroleum Co., Atomic Energy Div., Idaho Falls, Idaho). Paper 16 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.147-58.

A program to reduce the techniques of quantitative gamma-ray scintillation spectrometry to routine laboratory practice has been in progress at this laboratory for several years. recent investigations were directed to the improvement and extension of the gamma-ray spectrum catalogue originally compiled for the 3 × 3 in. NaI detector. The detector response to monoenergetic gamma sources and bremsstrahlung was studied in detail, with particular attention given to the effects of equipment stability, detector resolution, scattering geometry, and absorbing material introduced to attenuate unwanted radiation. The results of these studies are presented along with computer techniques developed for generating pulse-height distributions and quantitative analysis of data. An automatic data handling system for multichannel pulse-height analyzers is described which permits direct quantitative analysis of complex spectra in the analyzer memory through the use of auxiliary equipment with fast read-out and re-entry on perforated paper tape. An extended revision of the gamma-ray spectrum catalogue, containing over 250 spectra of nuclides and gross fission products, is presently being compiled in digital form on perforated tape. The application of these data is discussed in detail. (auth)

14438 (TID-7594(Paper 17)) NONLINEAR METHODS IN SPECTRUM UNSCRAMBLING. W. R. Burrus (Ohio State Univ., Columbus). Paper 17 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.159-67.

Some attempts to correct for instrumental smearing by analytical means give wildly fluctuating results for the desired incident spectrum. These spurious fluctuations are known to be due to an amplification of the inherent statistical errors in the experimental data. Since these methods produce nonphysical negative values for the calculated incident spectrum at some energies, it is reasonable to hope that the addition of a restriction which requires the calculated spectrum to be entirely positive would give "better" results in some sense. Some interim results of an investigation on the use of linear programming and quadratic programming to restrict the solution to positive values are presented. (auth)

14439 (TID-7594(Paper 18)) ANALYSIS OF GAMMA-RAY SPECTRA OBTAINED WITH AN NaI CRYSTAL WITH AN ANTICOINCIDENT ANNULUS. J. E. Monahan, S. Raboy, and C. C. Trail (Argonne National Lab., Ill.). Paper 18 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.168-87.

A computer program was developed to analyze complex gamma-ray spectra obtained with a scintillation spectrometer with an anticoincident annulus of NaI. The photopeaks are fitted with a least-squares calculation which assumed that the peaks are Gaussian. The contributions from Compton processes and pair production are removed by subtracting the isolated spectrum of each gamma ray, determined separately. The method permits the determination of the width, peak height, and channel position of each photopeak in the spectrum. A "chi-squared" test of the fit to the photopeaks is made. The uncertainties associated with the parameters include statistical uncertainties as well as any uncertainties from the non-Gaussian character of the photopeak. By this procedure the resolution function of the spectrometer and the energies of unknown gamma rays can be obtained in terms of standard lines in the spectrum. Relative intensities of the gamma rays may be obtained by dividing the product of the height and width (the relative area of the photopeak) by the photoefficiency obtained from a Monte Carlo calculation. (auth)

14440 (TID-7594(Paper 20)) COMPARATIVE PERFORMANCE OF WELL-TYPE VS. SOLID NaI(Tl) CRYSTALS. C. T. Schmidt (Harshaw Chemical Co., Cleveland). Paper 20 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.193-200.

When low-level radioactive samples are to be counted, a choice must be made regarding crystal geometry. Com-

parative counting efficiencies, photofractions, and resolutions are given for two 3 × 1½ in. solid crystals mounted back to back, and for two different 3 × 3 in. well types as a function of sample volume and energy. The well sizes were ¾ × 1¾ in. and 1⅞ × 2¾ in. The results show that for volumes greater than 20 cc, the use of two solid crystals gives detection efficiencies comparable to the large well and with much better resolution. For volumes less than 20 cc, the small well gives the highest detection efficiency. (auth)

14441 (TID-7594(Paper 21)) HIGH-ENERGY X-RAY SPECTROMETER USING LARGE ANTICOINCIDENCE SODIUM IODIDE CRYSTALS. James M. Wyckoff (National Bureau of Standards, Washington, D. C.). Paper 21 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.201-10.

A 9-in.-diam. by 6.25-in.-long crystal was used in a total absorption spectrometer for x rays in the 5- to 100-Mev range. The well-collimated x rays are directed onto the side and along a diameter of the main crystal. On the exit side, a 6.75 by 3.63 in. NaI crystal was set in anticoincidence to detect radiations above 0.6 Mev. The combination of the large crystal and the anticoincidence crystal improved considerably the resolution for high-energy x rays over the resolutions obtained with various combinations of crystals that were summed to provide a total absorption pulse. The final test of the resolution (and detailed response function shape) will come from the activation curve and (p,γ) data. The initial indications of the improved resolution will be demonstrated by the comparison of the shapes of pulse-height distributions produced by 90-Mev bremsstrahlung spectra transmitted by a 604-cm water attenuator. This spectrum has a characteristic dip at 22 Mev due to giant resonance nuclear absorption which required good resolution for its detailed observation. (auth)

14442 (TID-7594(Paper 22)) TOTAL GAMMA ABSORPTION IN NaI(Tl) AT 20.43 Mev. W. Del Bianco, H. Staub, W. E. Stephens, and G. Tessler (Pennsylvania. Univ., Philadelphia). Paper 22 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.211-16.

The total gamma absorption cross section was measured in NaI(Tl) at 20.43 Mev using monochromatic gamma rays from the $T(p,\gamma)He^4$ reaction. A 3-in.-diam. by 4-in.-long NaI(Tl) crystal was used as the absorber in a direct absorption measurement. The corrected value for the total absorption coefficient was found to be 0.166 ± 0.003 cm^{-1}. The value for the total cross section, deduced from the total absorption coefficient and using a density of 3.67 g/cm^3 for the NaI(Tl) crystal, was found to be 11.26 ± 0.21 b. The theoretical value for the total cross section is 11.10 b. The theoretical value includes pair production in the field of a nucleus, pair production in the field of an electron, Compton effect, photonuclear effect, and a small contribution from the photoelectric effect in iodine. The Coulomb correction to the pair production cross section, 5% for iodine, was obtained by interpolation of other experimental data at 17.6 Mev. (auth)

14443 (TID-7594(Paper 23)) TOTAL ABSORPTION OF X AND γ RAYS IN PLASTIC SCINTILLATORS. G. J. Hine and J. A. Cardarelli (Veterans Administration Hospital, Boston and Boston Univ. School of Medicine). Paper 23 of PROCEEDINGS OF THE TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY SYMPOSIUM, GATLINBURG, TENNESSEE, MAY 10-11, 1960. p.217-25.

Single lines corresponding to the full energy of monoenergetic x and γ rays incident on plastic scintillators were observed for the first time. Since the photoelectric absorption in carbon is very small, total energy absorption is due mainly to multiple Compton collisions followed by photoelectric absorption of the scattered radiation. For medium- and high-energy γ rays this requires rather large-size plastic scintillators. In contrast to large sodium iodide crystals, efficient light collection from large plastic scintillators cannot be achieved. It is demonstrated that the light losses due to multiple internal reflections of the fluorescent radiation become significant with increasing scintillator dimensions. By changing from cylindrical to conical shaped scintillators the light output is improved sufficiently to observe total energy absorption lines with 22- to 123-kev radiation. The ratio of pulses in the total energy peak to Compton region is improved considerably by using a plastic scintillator containing 2% lead by weight. However, a further reduction in light output from the lead-loaded plastic scintillator limits its useful dimensions to conical pieces of 2-in. base and height. (auth)

14444 (TID-11305) UNITIZED SYSTEM OF IMAGE INTENSIFIERS USING FIBER OPTICS. Progress Report No. 3, April-September 1960. J. S. Kalafut (Westinghouse Electric Corp. Electronic Tube Div., Elmira, N. Y.). Contract AT(30-1)-2176. 19p.

A description is given of the utilization of previously described methods for obtaining vacuum tight envelopes containing fiber optic faceplates, and the successes achieved by laying photocathodes and phosphors on the faceplates. (For preceding period see TID-5890.) (B.O.G.)

14445 (TID-12121) IMAGE INTENSIFIER DEVELOPMENT. Final Report. E. H. Eberhardt, S. F. Essig, and H. W. Baker (ITT Labs. Div. of International Telephone and Telegraph Corp., Fort Wayne). Feb. 24, 1961. Contract AT(11-1)-922. 77p.

The development of a two-stage magnetically focused image intensifier tube is outlined. The requirements for the tube were: resolution over entire screen = 35 line pairs/mm, S distortion ≤ 0.5 mm, sensitivity of input cathode = 40 μa/lumen, current gain of intensifier stage = 27, efficiency of output phosphor at 10 kv = 0.08 lumen/μa, and background brightness 0.5 μlambert. (D.L.C.)

14446 (TID-12132) A STUDY OF β SCINTILLATION COUNTING WITH PLASTIC PHOSPHORS. John H. Harley, Naomi A. Hallden, and Isabel M. Fisenne (New York Operations Office. Health and Safety Lab., AEC). Feb. 22, 1961. 17p.

A high-efficiency beta counter is described which is based on a thin plastic scintillator as the detector. Its major advantage is a background of less than 0.5 cpm without anticoincidence. The same basic system may be converted for alpha counting by substitution of ZnS on Mylar as the phosphor. (auth)

14447 (TID-12139) A SMALL-FOCAL-SPOT X-RAY GENERATOR USING BETA-RAYS. Sixth Quarterly Progress Report Covering Period September 1, 1960—December 1, 1960. Jacob Kastner, J. R. Parks, and M. H. Dickerson (Picker X-Ray Corp. Waite Mfg. Div., Inc., Cleveland). Contract AT(11-1)-746. 25p.

A fine focal spot self-powered x-ray generator was found to be feasible using β radiation as a power supply and field emission for x-ray generation. In this method the problem of β energy distribution was largely reduced, the efficiency limitation of the static system eliminated, and a storage system established so that activities much lower than the continuous 10^5 c/ma can be used. The utilization of the pole

structure of an anodized aluminum surface and of radiation-resistant epoxy resins in low concentrations for source mounting was investigated. (M.C.G.)

14448 (TID-12171) X-RAY FLUOR CALIBRATION. Technical Report No. 1. L. Evan Bailey and Bascom S. Deaver (Stanford Research Inst., Menlo Park, Calif.). Oct. 5, 1959. Project No. SD-2843-7. For Univ. of California. Lawrence Radiation Lab. 6p.

An investigation was conducted to determine the response of scintillation crystals and phototubes to x rays at 1 to 15 kev. The experimental data indicate that almost any commercially available scintillation crystal and phototube can be calibrated in this energy range. (B.O.G.)

14449 (TID-12176) AN IMPROVED CONTINUOUS INTERNAL-ELECTROLYSIS ANALYZER FOR GASEOUS FLUORIDES IN INDUSTRIAL ENVIRONMENTS. O. H. Howard and C. W. Weber (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1960?]. 32p.

The internal-electrolysis cell consists of an aluminum anode and a platinum cathode immersed in a dilute acid solution containing a known concentration of fluoride ions. The fluoride ions prevent the formation of aluminum hydroxide on the anode thus enabling a current to be produced which is a function of the amount of fluoride added. The range of detection for the analyzer is 0.05 to 80 μg F^- per liter of air. Potassium iodide is added to the electrolyte, when detecting elemental fluorine, to convert the fluorine to fluoride ions. The initial-response time is ~30 sec at 2 μg F^- per liter. The only recognizable interference is chloride which contributes a significant positive bias at low fluoride concentrations. (B.O.G.)

14450 (DEG-Inf.-Ser.-57) VERY SMALL PROBES FOR FLOW MEASUREMENT. R. Ramshorn. Translated by R. Presser (U.K.A.E.A., Risley) from VDI Zeitschrift, 101: 832-4(1959). 10p.

Very small quadruple flow-measurement probes of 2 and 3 mm tube diameter were developed. These probes will permit measurement of the magnitude and direction of air-flow velocity. They will give local back-pressure and the components of flow direction in two perpendicular planes directly. (auth)

14451 (DEG-Inf.Ser.-69) A NEW HIGH-SPEED CENTRIFUGE AND NEW LABORATORY CENTRIFUGE. E. Wiedemann. Translated by H. W. Curtis from Chem. Ingr. Tech., 28: 263-9(1956). 18p.

A description is given of the development and uses of a type of centrifuge, which was made possible by the construction of a new high-speed centrifuge and new laboratory centrifuges. The machines have in common exceptionally quiet running, high insensitivity to unequal loads, and a very good temperature constant at very high normal acceleration values, so that their field of application can be very much extended. (auth)

14452 (NP-tr-587) OSCILLOGRAPHIC METHOD OF MEASURING THE RATE OF MOTION OF A METAL IN A CASTING MOLD. T. I. Orlova. Translated from Liteinoe Proizvodstvo, No. 7, 25-7(1954). 9p.

The rate of motion of a metal in a casting mold was measured by the oscillographic method. Contacts were placed in the molds and coupled with a series of resistances which were included in the electric circuit of the oscillograph loop. Metal moving in the molds closed the contacts and at the same time took out one after another the resistances from the circuit of the loop. Each step in the oscillogram corresponded to the moment the resistance was taken out of action by the metal flowing in the mold. The oscillographic method was employed for measuring the initial rate of motion of the metal in castings and for measuring the rate of flow of the metal in the range of precrystallization temperatures for the purpose of establishing the relationship between the fluidity and the rate of flow of the molten mass. It was established that all the investigated metals and alloys in identical pouring conditions are characterized by a uniform rate of flow along the analogous sections of the channel regardless of overheating. (M.C.G.)

14453 CORRECTION FOR QUENCHING ASSOCIATED WITH LIQUID SCINTILLATION COUNTING. Gerald A. Bruno and John E. Christian (Purdue Univ., Lafayette, Ind.). Anal. Chem., 33: 650-1(Apr. 1961).

A simple, accurate procedure is described for correcting counting errors due to quenching in small-volume liquid scintillation detection methods. The method is only valid for higher activities and does not appear to be appropriate for routine counting operations. The method is based on the fact that the ratio of the counting rates between the two windows is a measure of the degree of quenching. Representative C^{14} quenching factors and calculated errors for various levels of activity are tabulated. A tabulation of error determinations for various quenching materials and comparison to internal standard error determinations is also given. (N.W.R.)

14454 ABSORPTION CELL ATTACHMENT FOR A WELCH DENSICHRON REFLECTION UNIT. F. J. Miller and H. C. Jones (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 651-2(Apr. 1961).

A Welch Densichron densitometer was modified by encasing the reflectance head in a slotted Lucite case to which is attached an absorption cell. The slot in the Lucite case enables reflectance measurements to be made on squares of white blotter paper. The absorption cell attachment permits the measurement of the absorbance of colored solutions. Either reflectance or absorbance measurements can be made remotely. The modifications made on the instrument enable a change-over to be made from visual spot test control procedures to an instrumental method that can be used remotely within hot cell facilities. (auth)

14455 AUTOMATIC ACCOUNTING SYSTEMS FOR NUCLEAR PHYSICS MEASUREMENTS. G. Colombo (Centro di Studi Nucleari, Ispra, Italy), E. De Agostino, and U. Pellegrini. Automazione e strumentazione, No. 5: 195-8(1960). (In Italian)

A survey is made of automatic accounting systems used in nuclear physics tests. In particular a transistor two-cycles timer for prefixed time measurements is described, as well as the electronic equipment annexed to the crystal spectrometer for the Ispra-1 reactor. (auth)

14456 MICROWAVE INTERFEROMETER WITH COHERENT BACKGROUND. A. Boivin and R. Tremblay (Universite, Laval, Quebec). Can. J. Phys., 39: 393-408 (Mar. 1961). (In French)

A new type of microwave interferometer based on the free propagation of the reference signal is described. The apparatus was developed for the study of the distribution of complex amplitude in the diffraction image produced by a microwave optical system. The method is essentially based on the principle of coherent background, use being made of properly polarized sources and of the "turnstile antenna" as a detector. The diffraction pattern is scanned twice to determine the distribution of complex amplitude in Cartesian form, both the real and imaginary parts. With the aid of such a coherent background interferometer, the complex amplitude distribution was studied in the diffraction pattern

at different planes in the image space of an aberration free microwave system. The results obtained are remarkably close to the theoretically predicted ones and, moreover, permit the evaluation of the characteristics and possibilities of this interference technique. This study shows that the coherent background interferometer will permit measurements of diffraction phenomena in the domain of millimeter waves, which are more appropriate for this type of study. (auth)

14457 MICROWAVE PHASE SHIFTER WITH DIELECTRIC PRISMS. R. Tremblay (Universite, Laval, Quebec). Can. J. Phys., 39: 409-18(Mar. 1961). (In French)

A new type of microwave phase shifter was constructed. In this device, a dielectric plate with parallel faces passes through two longitudinal slits on the larger faces of a rectangular waveguide. This plate is formed of two identical prisms placed in opposition. The displacement of one of the prisms relative to the other along the hypothenuse changes the effective length of the dielectric plate within the guide, with a consequent shift of the wave that traverses this quadrupole. The possibility of designing a phase shifter of this type using only a single prism is also discussed. The characteristics of this type of variable phase shifter are as follows: high phase resolution, 0.7°; easy matching, S.W.R. of 1.05; weak sensitivity to frequency variations; phase shift linear with respect to the displacement of one of the prisms; and very simple mechanical construction. (auth)

14458 A NEW METHOD FOR THE STUDY OF ULTRA-SHORT SCINTILLATIONS. Yves Koechlin. Compt. rend., 252: 391-3(Jan. 16, 1961). (In French)

A new method for the study of ultra-short scintillations is described. It consists of the determination of the distribution of the moments of photon emission from the scintillations with respect to an original time defined in a precise fashion. The utilization of photomultiplier 56 AVP permits the application of this method to the study of scintillation form with a time precision of 0.27 ns. (tr-auth)

14459 A SPEED SELECTOR WITH A CHANNEL USING THE CHERENKOV EFFECT. Jean-Claude Dumas, Claude Mabboux, and Raymond Moch. Compt. rend., 252: 547-9 (Jan. 23, 1961). (In French)

The use in anticoincidence of two gas Cherenkov counters whose thresholds are slightly out of phase permit the realization of a detector sensitive only to high-energy particles whose speed is between β and $\beta + \Delta\beta$. The preliminary results obtained are encouraging. (tr-auth)

14460 A METHOD FOR THE INVESTIGATION OF COMPLICATED NUCLEAR REACTIONS. A. V. Kulikov, V. P. Chizhov, and I. P. Yavor (Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 77-80(Jan. 1, 1961). (In Russian)

Descriptions are given of a device for use with a charged particle accelerator which tracks and records the energy, mass, and trajectories of fast particles. The device consists of a Wilson chamber, scintillation telescope, and circuitry for synchronizing the operations of the two first elements with the particles. Pictures of photospallations in the Wilson chamber at a maximum γ energy of 90 Mev are included. The γ beam was cleared of electrons and positrons. The Wilson chamber was filled with nitrogen and hydrogen in a 1:1 proportion. Preliminary experiments indicate the applicability of the device to studies of complex photospallations such as (γ,pn), (γ,dn), $(\gamma,2p)$, (γ,dp), and other reactions. It can also be useful in studies of reactions excited by protons and neutrons. (R.V.J.)

14461 SIMPLE MEASUREMENT METHODS FOR THE DETERMINATION OF BREMSSTRAHLUNG TOTAL ENERGIES IN THE PRESENCE OF STRONG ELECTROMAGNETIC PERTURBATION FIELDS. A. Eckardt and E. Burger (Friedrich-Schiller-Universität, Jena, Ger.). Exptl. Tech. Physik, 8: 210-16(1960). (In German)

Total energy determinations can be made by a systematic decrease of the electron expenditure when the usual electronic auxiliaries are no longer dependable because of the electromagnetic perturbation effects. The measurement accuracy of this method is sufficient for average requirements. (tr-auth)

14462 STUDY OF THE DRYING AND RESTORATION OF NUCLEAR EMULSIONS WITH THE AID OF A POLYETHYLENE GLYCOL (CARBOWAX). L. Pinto Hespanhol (Ecole Polytechnique de l'Universite, Lausanne, Switzerland), A. Samman, and G. Vanderhaeghe. Helv. Phys. Acta, 33: 983-5(1960). (In French)

A polyethylene glycol (Carbowax) was used for drying and restoring the thickness of nuclear emulsions. Ilford G-5 emulsions, exposed to relativistic mesons, were developed by the usual dithermal method. After washing, the plates were placed in Carbowax and their decrease in thickness immediately after drying was measured in the same liquid. The distortions obtained were compared with those resulting from other drying methods. The results show that the smallest distortion is obtained when the water of the photographic layer is eliminated progressively by placing the plate in solutions of Carbowax or alcohol of increasing concentrations. (J.S.R.)

14463 CORROSION OF PHOTOGRAPHIC TRACTS IN NUCLEAR EMULSIONS DURING FIXING. L. Pinto Hespanhol (Ecole Polytechnique de l'Universite, Lausanne, Switzerland). Helv. Phys. Acta, 33: 994-5(1960). (In French)

The corrosion of nuclear tracks in 600-μ Ilford emulsions G5, K5, and L4 was studied as a function of the fixing time for fixing baths of different pH and temperature. The composition of the fixing bath was sodium thiosulfate, 400 g/l; anhydrous sodium sulfate, 10 g/l; and glacial acetic acid, $\underline{x}$ cm^3/l ($\underline{x}$ varying from 0.5 to 25). The corrosive effect of the bath was followed by measuring the grain density of the tracks, the blackening density, and the diameter of the track grains and plate grains. In the G5 and K5 emulsions the beginning of corrosion was observed at pH 4 and 5. Increased temperature caused corrosion to start in four days. At pH 6 no appreciable corrosion was detected even after 15 days in the fixing bath. Elevation of the pH above 6 prolongs the fixing time and produces clouding even when there is no corrosion. (J.S.R.)

14464 CRITERIA FOR EVALUATING COLLIMATORS USED IN IN VIVO DISTRIBUTION STUDIES WITH RADIOISOTOPES. W. C. Dewey and W. K. Sinclair (Univ. of Texas, Houston). Intern. J. Appl. Radiation and Isotopes, 10: 1-16(Feb. 1961). (In English)

In many practical circumstances involving the localization of radioactive regions in the body, the highest resolution is not necessarily desirable because of the accompanying reduction in sensitivity. A compromise must therefore be effected between resolution and sensitivity. Principles are presented for effecting this compromise and a figure of merit is defined in order to determine which collimator-detector system provides the highest probability of detecting a radioactive target located inside a region with a different concentration of radioactivity. A most important factor is the ratio of target-to-nontarget sensitivity which

depends on both the shielding of the detector and the collimator construction. Three different focusing collimators having 91, 19, and 7 holes, respectively, and two single-bore collimators, 3 and 5 in. in length, were studied. It was found that the most suitable collimator for detecting a given target depends on the size of that target. For example, of the compromises available, a collimator with very good resolution and low sensitivity is best for small targets, while for larger targets a collimator with low resolution and high sensitivity is best. Two other questions of interest are considered. First, the distortion in the representation of the target, which varies with target size, is specified in terms of a parameter called specific resolution. Second, the concentrations of radioactivity needed for given scinti-scanning situations can be calculated by means of an equation which is derived. An application of the equation to a practical case in brain-tumor scanning is presented. (auth)

14465 A SIMPLE METHOD FOR THE DIFFERENTIAL COUNTING OF RADIOACTIVE IRON (Fe^{59}) AND CHROMIUM-51 IN MIXTURES. L. A. Walker, G. Sparling, and H. Mercer (Mason Clinic, Seattle). Intern. J. Appl. Radiation and Isotopes, 10: 17-21(Feb. 1961). (In English)

A method is described for accurately counting Cr^{51} and Fe^{59} in mixtures. This method makes use of only a scintillation counter and associated scaler. Neither lead filters nor gamma spectrometer is needed, and the accuracy is as good as that of either of the other two methods. (auth)

14466 SELF-ABSORPTION OF CARBON-14 SAMPLES ON THIN PAPER PLANCHETS. E. R. Powsner (Veterans Administration Hospital, Dearborn, Mich. and Wayne State Univ., Detroit). Intern. J. Appl. Radiation and Isotopes, 10: 22-9(Feb. 1961). (In English)

Using C^{14} samples absorbed on thin paper discs, the apparent radioactivity of samples of glycine and hemin was measured in a gas-flow counter over a wide range of specimen thickness. Results show that specimens ranging up to a thickness of 150 $\mu g/cm^2$ may be regarded as approximately infinitely thin. It is estimated that the count rate is decreased by approximately 20% as a result of absorption of the radioactivity by the paper. To a considerable extent, the change in count rate due to self-absorption varies as the reciprocal of a linear function of the thickness of both the paper and the specimen. (auth)

14467 EFFICIENCIES AND PHOTOFRACTIONS OF SOME COMMONLY USED NaI(Tl) WELL CRYSTALS. S. V. Nablo and T. C. Martin (Convair, Fort Worth, Tex.). Intern. J. Appl. Radiation and Isotopes, 10: 55-60(Feb. 1961). (In English)

A knowledge of the ratio of the number of gamma rays that are completely absorbed in the crystal to the total number of gamma rays that interact at least once is necessary in evaluating a detector for applications involving selective pulse-height analysis. A calculation of this ratio, called the photofraction, p(E), is complicated by the variable source volumes encountered in practice, and, as a result, an empirical study of p(E) as a function of crystal and sample geometry was made for four different scintillation spectrometers. (auth)

14468 UNDESIRED BACKGROUND SUBTRACTION IN A LOGARITHMIC COUNT RATE METER CIRCUIT. Harold E. DeBolt (AVCO, Wilmington, Mass.). IRE Trans. Nuclear Sci., NS-8: No. 2, 1-3(Apr. 1961).

Background compensation can be accomplished by simple subtraction of a background signal in the linear count rate meter. However, in the logarithmic count rate meter circuit (Cooke-Yarborough type), compensation must be accomplished by subtraction from each section of the logarithmic circuit before summing the outputs of the sections. The method is described and mathematically justified. (auth)

14469 A MATHEMATICAL METHOD OF ANALYSIS FOR PREDICTING THE PERFORMANCE OF AN ANTI-COMPTON GAMMA RAY SPECTROMETER. J. S. Rosen, J. C. Whiton, and C. W. Hill (Lockheed Aircraft Corp., Marietta, Ga.). IRE Trans. Nuclear Sci., NS-8: No. 2, 4-12 (Apr. 1961).

A mathematical model is developed for estimating the performance of an Anti-Compton gamma ray spectrometer. This spectrometer consists of a small cylindrical crystal surrounded by a larger, hollow cylindrical crystal, both composed of NaI(Tl). The results of a study of two-parameters, incident gamma ray energy and relative crystal position, are given. (auth)

14470 MEASURING SENSITIVENESS AND MEASURING ACCURACY IN INDUSTRIAL β-RAY THICKNESS MEASUREMENT. W. Dietzsch. Isotopentechnik, 1: 66-9(Jan. 1961). (In German)

The voltage compensation that must be made on an isotope measuring instrument, for obtaining optimum sensitiveness and accuracy of measurement, is examined. For quantitative calculations, the parameters of the thickness gauge VA-T-70, manufactured by VEB Vakutronik Dresden, are used. (auth)

14471 THICKNESS MEASUREMENTS OF ANODIC COATINGS BY MEANS OF β-BACKSCATTERING. E. Dahn (Institut für Angewandte Radioaktivitat, Leipzig). Isotopentechnik, 1: 69-70(Jan. 1961). (In German)

By means of test measurements it is shown that the thickness of anodic coatings up to 25 μm may be measured to within ± 10% by applying the β-backscattering method. Source of radiation used is Pm^{147}. (auth)

14472 AMPLITUDE ANALYZER OF NUCLEAR EMISSION SPECTRA. V. O. Vyazemskii, Yu. M. Kazarinov, and V. V. Trifonov (Leningrad Electric Engineering Inst.). Izvest. Leningrad. Elektrotek. Inst., No. 38: 237-48(1959).

The 128-channel analyzer (AMA-3s) is described with recorder at the potentialoscope (LN-4). The capacitance of every channel amounts to 2^{16} pulses. The (average) resolving time is (0.5 n + 22) μsec, where n is the number of the channel. The measurement results may be read in several ways. They may be read in the form of 16-digit binary numbers from the screen of the monitor tube or channel-like from the neon indicators. The possibility of choosing the channel is provided. They may also be read in the form of a histogram on the monitor screen, where the histogram can be observed in the spectrum setting process. The histogram scale may vary from 512 to 65,000 pulses over the entire screen. The spectrum histogram can be traced automatically by the recording instrument (EPP-0.9). The instrument can be actuated either by coincidences or anti-coincidences with the external controlling pulses. The pulse recording in the AMA-3s analyzer proceeds as follows: the incoming pulse hits (after being amplified in the linear amplifier) the input of an amplitude-time converter, where it is transformed into a square pulse, the duration of which is proportional to the amplitude of the input signal. This pulse controls the generation of a train of pulses, the number of which is also proportional to the amplitude of the input signal. The pulse train appears as digital address of the memory cell and is directed to the "address device." The latter represents a binary counter, each of whose cells is connected with a special key. The output currents of the

keys cause a voltage drop in the general load, which is proportional to the number of pulses in the train. This voltage is applied to the horizontally deflecting plates of a potentialoscope, providing for the incidence of the potentialoscope beam on the first storage element of the storage cell chosen by the location system. After the storage cell is chosen the recording of the pulse begins. The pulse recording program in the storage cells of the chosen channel is described. Having finished the recording of the present pulse, the "reset pulse" will be produced, which discharges the counters of the location cells to "zero-charge" and frees the analyzer entrance. (TCO)

14473 INTERPRETATION OF EXPERIMENTAL CHARACTERISTICS OF CESIUM THERMIONIC CONVERTERS. E. N. Carabateas (Massachusetts Inst. of Tech., Cambridge), S. D. Pezaris, and G. N. Hatsopoulos. J. Appl. Phys., 32: 352-8(Mar. 1961).

Experimental V-I curves were obtained from a 150-w cesium thermionic converter. Two different kinds of V-I curves can be clearly distinguished. One, corresponding to a collision-free type operation, is obtained when the cesium mean free path is of the order of three or more times the interelectrode spacing. The other, corresponding to a sheath-type operation, is obtained when the spacing is of the order of 30 cesium mean free paths. In the first case the log I vs V plot has the familiar shape observed by Hernqvist et al. [K. G. Hernqvist, M. Kaneisky, and F. H. Norman, RCA Rev. 19, 244 (1958)]; it consists of two straight lines meeting at the breakoff point. From such an experimental curve the difference in emitter and collector work functions and the emitter temperature can be readily obtained. In the second case the V-I curve has the standard shape of a sheath curve which is smooth without breakoff point and which shows saturation in the current for both the high positive and high negative values of the voltage. In the present work a method is outlined by means of which the difference in emitter and collector work functions, as well as the emitter temperature, can be determined from an experimental V-I curve of the second kind. With this method experimental data from the above-mentioned converter in the sheath-type operation have been successfully analyzed, and good agreement has been obtained between experimental results and theoretical predictions. (auth)

14474 CHEMICAL INSTRUMENTATION. 13. NUCLEAR RADIATION ELECTRONIC GEAR. S. Z. Lewin (New York Univ., New York). J. Chem. Educ., 38: A225-6; A229-30; A234; A238; A241(Apr. 1961).

The basic principles, characteristics, and limitations of electronic circuitry needed with radiation detectors are given. Fundamental types are power supplies, amplifiers, and scalers. Commercially available equipment is listed, and approximate prices are quoted. (N.W.R.)

14475 INTRODUCTION OF CENTRAL RADIATION MEASUREMENT DEVICES IN NUCLEAR ENGINEERING OPERATIONS. M. Oberhofer (Technische Hochschule, Munich). Kerntechnik, 3: 28-32(Jan. 1961). (In German)

The advantages of central radiation measurement devices with respect to decentralized measurement are discussed, and the advantages and disadvantages of ionization chambers and Geiger installations are considered. By using the FRM double-counter installation as an example, the radiation protection and operating significance of this type of installation are shown. (tr-auth)

14476 INVESTIGATIONS ON HOW TO IMPROVE THE RESOLVING POWER SINGLE CRYSTALS SCINTILLATION GAMMA-SPECTROMETERS. G. Máthé (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Magyar Tudományos Akad. Atommag Kutató Intezéte (Debrecen). Közlemények, 2: No. 3, Suppl., 6p.(1960). (In English)

In the region of energy where scintillation gamma spectrometers are applied, the number of visible photons produced by gamma rays is extremely small. Thus statistical fluctuation, partly in the number of photons but mainly in that of photoelectrons from the photocathode of the electron multiplier, is great enough to limit the accuracy of energy measurements. Methods are described whereby the number of applicable photoelectrons and, in consequence, the resolving power can be increased to the greatest possible extent. This is achieved partly by the maximal utilization of the light arising in the crystal, partly by the optimal adjustment of the electron multiplier and that of contiguous electronics. (auth)

14477 THE UNDERGROUND, SEMI-CUBIC GEOMETRY COUNTER TELESCOPE CONSTRUCTED FOR THE IGY AND THE FIRST MEASUREMENTS MADE WITH IT. Tamás Sándor, Antal Somogyi, and Ferenc Telbisz. Magyar Tudományos Akad. Központi Fiz. Kutató Intézetenek Közleményei, 6: 117-28(1958). (In Hungarian)

Within the cooperative framework of IGY, the intensity variations of cosmic radiation were determined by using 2 identical, independent, wide-angle counter telescopes with semi-cubic geometry. The instruments were placed in a shaft at the Cosmic Ray Laboratory at a depth of 20 m. The 18-m thick layer of earth above the instruments filtered out the soft component of the radiation, resulting in a detection threshold value of about 6×10^3 Mev for the meson component. The measurements were aimed at the examination of the atmospheric effect of the penetrating radiation, the determination of seasonal variations and the interpretation of sudden, short-life intensity changes. During the period from Feb. 20 to March 9, 1958, on the basis of the study of 18.5 million coincidences the absorption and decomposition coefficients were found to be (-0.58 ± 0.04) ‰/mm [‰ (per thousand)] of Hg and (-1.03 ± 0.23) %/km, respectively. The instability of the instrument amounted to 0.2% which can be explained by the dead time due to background variation and the variation of the number of the coincidences. (TTT)

14478 RADIOFREQUENCY ENERGY MODULATION IN THE CASE OF A THONEMAN ION SOURCE. János Erő. Magyar Tudományos Akad. Központi Fiz. Kutató Intézetenek Közleményei, 6: 129-37(1958). (In Hungarian)

An analyzer was constructed for detecting the energy spectrum of an ion beam by means of a scintillation counter within about 25 μsec, differentiating between low and radiofrequency modulations. Under the operating conditions used, a radiofrequency modulation of the order of 50 to 60 ev could be detected. The spectrum presented the characteristic amplitude distribution of $1/\sqrt{a^2-y^2}$. The energy modulation was stopped by passage through a demodulating radiofrequency space of suitable size and phase, reducing the width of the spectrum to less than 15 ev, and keeping the scattering considerably below the 3% level. Time-of-flight measurements indicated that the primary modulation occurs in the cathode dark space. (TTT)

14479 STUDY OF PLASTIC PHOSPHORS FOR MEASURING NEUTRON ENERGIES. András Neszmenyi and Gabriella Pálla. Magyar Tudományos Akad. Központi Fiz. Kutató Intézetenek Közleményei, 6: 138-46(1958). (In Hungarian)

The nonlinear behavior of organic phosphors in the relation of light output to energy loss was the subject of a number of investigations in the case of anthracene and liquid

phosphors but there is only one publication on the field of plastic phosphors (Boreli-Grimeland, Nuovo Cimento II, 336(1955), Aug.). For this reason a comparative study of foreign and native plastic phosphors was undertaken, determining the correlation between the light emission generated by α particles and electrons. It was found that the value of the extinction coefficients varies between 12.4 and $15.4 \cdot 10^{-3}$ g/Mev cm^2. The machinability and the short decay times of the plastic phosphors make them useful for neutron measurements, relying on a large volume for obtaining the required efficiency. (TTT)

14480 CHEMICAL DOSIMETRY OF THE GAMMA RADIATION OF ACTIVE FUEL ELEMENTS. R. Häberli and H. Schmied (Institut fur Reaktorforschung, Wurenlingen, Switzerland). Neue Tech., 2: No. 12, 18-24(Dec. 1960). (In German)

The utilization of radioactive fuel elements for gamma irradiations makes necessary the chemical determination of the radiation doses. This paper describes the dosimetry with four chemical systems, the chemical composition of the dosimeters, and their preparation. Finally the application possibilities are described. (auth)

14481 THE DEVELOPMENT TIME OF CLOUD TRACKS IN CLOUD CHAMBERS. Ludwig Meyer (Kernphysikalisches Institut, Akademie der Wissenschaften, Berlin). Nuclear Instr. & Methods, 10: 108-12(Feb. 1961). (In German)

The development of cloud-chamber tracks of ionizing particles is investigated in several gases with various densities of ionization. It is shown that the intensity of light scattered from these tracks, which is proportional to the droplet cross sections, increases linearly with time only in a small initial time interval of some 10^{-2} seconds, whereas the further growth proceeds substantially slower. Calculations and measurements concerning this process are given for α-particles as well as for slow and fast electrons in argon, air, and hydrogen. (auth)

14482 INVESTIGATIONS ABOUT THE CRITICAL RADIUS OF THE BF_3 COUNTERS. J. Csikai, E. Molnar, and B. Schlenk (Atomki, Debrecen, Hungary). Nuclear Instr. & Methods, 10: 121-4(Feb. 1961). (In English)

No critical radius is found in the investigated BF_3 proportional counter. Alpha-particles are introduced parallel with the anode into the mica end-window counter filled with BF_3-gas at 150 Hgmm, and the radial change of the number of impulses is thus studied. In the counter filled with BF_3-gas at 150 and 300 Hgmm, the integral amplitude distribution is investigated as a function of electronic amplification at various distances of the source from the anode. (auth)

14483 A DOUBLE-FOCUSING MAGNETIC SPECTROMETER FOR STUDIES OF ENERGY LOSSES IN MATTER OF ELECTRONS FROM A 5 Mev BETATRON. Torbjorn Westermark (Royal Inst. of Tech., Stockholm). Nuclear Instr. & Methods, 10: 129-44(Feb. 1961). (In English)

A discussion is given of the best choice of energy region and electron source for an energy loss study program with emphasis on chemical valence effects on stopping power. The particular role played by multiple scattering and bremsstrahlung is stressed and a few Mev selected as the appropriate energy region. A 5 Mev betatron designed and constructed by Wernholm and Smårs is used as the electron source. A double-focusing 90° sector type magnetic spectrometer is described and its focusing properties studied. The electrostatic technique for measuring line-widths is used. (auth)

14484 MULTICHANNEL DETECTOR FOR USE IN PARTICLE SPECTROMETERS. Bent Elbek and Michiyuki Nakamura (Univ. of California, Berkeley). Nuclear Instr. & Methods, 10: 164-8(Feb. 1961). (In English)

A 15-channel scintillation counter was constructed for use in magnetic spectrometers with extended focal line. It utilizes 15 organic scintillators placed along the focal line. The scintillators are optically coupled in binary code to four photomultiplier tubes. The output pulses from these tubes are electronically converted into standard current pulses (weighted 1, 2, 4, 8) in a common resistor. The resulting voltage pulse is proportional to the position of the scintillator giving the light pulse, and can be displayed on a "kicksorter." The results of an experimental test of the multichannel electron detector are described. (auth)

14485 BETA-GAMMA DELAYED COINCIDENCE METHOD FOR RESONANCE ESCAPE MEASUREMENTS. Laurence S. Beller (Atomics International, Canoga Park, Calif.). Nuclear Sci. and Eng., 9: 411-12(Mar. 1961).

The $Np^{239} \rightarrow Pu^{239}$ decay, resulting from neutron capture in U^{238}, may be identified by measurements of delayed β-γ coincidence. The method makes use of the fact that about half the β decays of Np^{239} feed a γ-emitting state of 0.193-μsec half life. In principle, a β-γ coincidence measurement is made after first delaying the arrival of the β pulse at the coincidence circuit for a time sufficiently long to reject similar β-γ events among fission products having half lives shorter than the desired state, prompt β-γ events, and false prompt coincidences caused by bremsstrahlung and related events. Advantages and disadvantages are given for this method. (N.W.R.)

14486 THE SELECTIVE MEASUREMENT OF NEUTRON AND PHOTON DOSES WITH AN ETHYLENE DOSIMETER. Franz Ph. Pott and Siegfried Wagner (Physikalisch-Technische Bundesanstalt, Brunswick). Nukleonik, 2: 271-6(Dec. 1960). (In German)

Measurement with an ethylene-polyethylene proportional dosimeter gave, for fast neutrons from a Ra(α)Be source, a dose which is approximately 6% under the value to be expected from theory. This deviation was traced back to experimental and theoretical uncertainties. Measurements of photon doses, in which similar counters were used as ionization chambers with gas amplification, show the proportionality to be expected for doses in ethylene and air for energies from 150 kev to above 1 Mev. If both measurement methods are combined, neutron and photon doses in a mixed radiation field can be measured simultaneously in ethylene. The tissue doses of interest can be obtained by calculation. In an example the doses produced by shielded and unshielded Ra(α)Be sources were determined. (tr-auth)

14487 FLUCTUATIONS IN AN OSCILLATOR ON A REFLEX KLYSTRON DEPENDING UPON ELECTRON VELOCITIES DISTRIBUTION BY SHOT AND THERMAL EFFECTS. E. N. Bazarov and M. E. Zhabotinskii. Radiotekh. i Elektron., 6: 166-9(1961). (In Russian)

Symbolic equations and correlation theory are used in an investigation of fluctuations in a reflex klystron oscillator produced by electron velocity spread and by fractional and thermal effects. Expressions are developed for mean square amplitude fluctuations, the phase, and the oscillation spectra. It is shown that under certain conditions the electron velocity spread can considerably affect the fluctuations. (tr-auth)

14488 TRANSISTORIZED PRECISION RATEMETER. G. Giannelli and V. Mandl (Centro Studi Nucleari, Ispra, Italy). Rev. Sci. Instr., 31: 623-5(June 1960). (CNI-41)

A linear ratemeter based on a special circuit with a saturated-core blocking oscillator is described. This cir-

cuit feeds a capacitance with a calibrated quantity of electric charge for every input pulse. The instrument is characterized by an absolute zero stability, a good linearity, and independence from temperature. (auth)

14489 HIGH RESOLUTION FOCUSING ČERENKOV DETECTOR FOR HIGH ENERGY PARTICLES. D. A. Hill, D. O. Caldwell, D. H. Frisch, L. S. Osborne, D. M. Ritson, and R. A. Schluter (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 32: 111-21(Feb. 1961).

A focusing differential Cherenkov counter of high-velocity resolution using a gas radiator was developed and used in relativistic particle beams. The optical and mechanical features are described. The velocity β can be varied continuously from 0.81 to 1.00. These counters give a velocity resolution $\Delta\beta/\beta$ of 0.0025 (half-width at half-maximum) at $\beta = 0.9985$ and an average efficiency for a 4-in.-diameter particle aperture of 0.7 in a particle beam collimated to $\pm 1°$. The sources of spurious response and the ultimate limitations of counters of this type are discussed. (auth)

14490 PHOTON-COUNTING SPECTROMETER FOR ATTENUATION MEASUREMENTS IN THE SOFT X-RAY REGION. D. E. Bedo and D. H. Tomboulian (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instr., 32: 164-8(Feb. 1961).

A grazing incidence spectrograph, originally designed for photographic registration, was modified for the purpose of making attenuation measurements at selected wavelengths in the 100 to 300 A region. The modifications over previous procedures include: the introduction of an open multistage copper-beryllium electron multiplier for the purpose of comparing intensities by counting photons and the use of the characteristic valence emission bands of the light metals as sources of incident radiation. The photomultiplier was mounted on an arm attached to a spindle whose axis was normal to the base plate and passed through the Rowland circle at the selected wavelength. Defining slits, placed between the grating and entrance window of photomultiplier, limited the spectral band used in irradiating the absorbers. The latter were placed in the diffracted beam at the position of "least confusion" and could be rotated independently about the common vertical axis of the spindle, thus varying the angle at which the incident beam strikes the surface of the sample. Various tests indicated that the source intensity and detector sensitivity are adequate for the attainment of satisfactory counting rates. In conjunction with the particular sources referred to, the photon-counting scheme makes it possible to improve materially the precision of existing attenuation measurements. (auth)

14491 HODOSCOPE FOR LOW LEVEL OUTPUT PARTICLE DETECTORS. L. D. Heggie and G. E. Masek (Univ. of Washington, Seattle). Rev. Sci. Instr., 32: 193-4(Feb. 1961).

A scheme of combining a large number of low-level output particle detectors into a hodoscope is described. Features include economy of amplification equipment and a short resolving time against accidental events. (auth)

14492 STATISTICS OF ELECTRON MULTIPLICATION. Francis J. Lombard and Fred Martin (Univ. of California, Livermore). Rev. Sci. Instr., 32: 200-1(Feb. 1961). (UCRL-6046)

The pulse-height distribution at the output of an electron multiplier structure for a single electron input was calculated assuming a Poisson distribution at each stage. Graphs are given which illustrate the change in pulse-height distribution as a function of the number of stages. This was done for interstage multiplications of 1.5, 2.0, 3.0, and 5.0. (auth)

14493 METHOD FOR DETERMINING THE PHOTOPEAK EFFICIENCY OF SCINTILLATION COUNTERS. John B. Ashe and James H. McCrary (Texas Nuclear Corp., Austin). Rev. Sci. Instr., 32: 205-6(Feb. 1961).

A technique for determining the photopeak efficiency of certain scintillation counters for γ rays, by detecting coincident radiations with a single NaI(Tl) counter, is described. The method is based on the fact that, for coincident radiation, a detecting system presenting 4π steradians to the source has an efficiency $\epsilon(\gamma_1)$ for detecting a quantum γ_1 and an efficiency $\epsilon(\gamma_1)\epsilon(\gamma_2)$ for detecting both quanta simultaneously. (M.C.G.)

14494 MULTIPLE APERTURE SLITS FOR MOLECULAR BEAM SOURCES. Sheldon Datz, Robert E. Minturn, and Ellison H. Taylor (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 32: 210(Feb. 1961).

The intensity of molecular beams can be increased by the use of multiple aperture slits. A "crinkly foil" slit was developed by Zacharias and Haun, but the beam coming from it did not have a maxwellian velocity distribution because the individual sources were canals rather than ideal slits. For those cases where a maxwellian velocity distribution is desirable, a multiple aperture slit may be made from commercially available electroformed nickel mesh. (M.C.G.)

14495 LARGE GAS ČERENKOV COUNTER. R. J. Swanson and G. E. Masek (Univ. of Washington, Seattle). Rev. Sci. Instr., 32: 212(Feb. 1961).

A large gas Cerenkov counter used to discriminate between pions and muons of 2 Bev/c is described. The counter can resolve β differences of the order of 0.0010. The rejection ratio of the system is approximately 0.004. The construction of the counter is similar to that of other gas counters and differs from them principally in its size and the Fresnel lens-focusing arrangement. (M.C.G.)

14496 PHOTOMULTIPLIER IONIZATION GAUGE. H. Riemersma, R. E. Fox, and W. J. Lange (Westinghouse Research Labs., Pittsburgh). Rev. Sci. Instr., 32: 218-19 (Feb. 1961).

To avoid ambiguity and to facilitate study of the interaction between a hot filament and the surrounding gas, a cold cathode ionization gage was developed. A photomultiplier was used as the source of electrons. The gage operation at pressures less than 10^{-3} torr can be represented by the equation $(I_{ic} - I_s)/I_t = K_p$ where I_{ic} is the total ion collector current ($I_t + I_s$), K is gage sensitivity, and p is pressure. The procedure for optimum operation is outlined. (M.C.G.)

14497 ELECTRICAL CURRENT SHIMS FOR CORRECTING MAGNETIC FIELDS. Weston A. Anderson (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instr., 32: 241-50(Mar. 1961).

The design criteria of electrical current shims for high resolution nuclear magnetic resonance magnets are discussed. Specific current configurations are given for various corrections to magnetic field gradients of the first, second, third, and fourth orders. (auth)

14498 UTILIZATION OF OPTICAL FILTERS IN A SCINTILLATION DETECTOR. Elihu Boldt and Costa Tsipis (Rutgers Univ., New Brunswick, N. J.). Rev. Sci. Instr., 32: 280-1(Mar. 1961).

The detector described consists of a block of plastic scintillator covered by a 4π anticoincidence shield of scintillation plastic sheets. By means of optical filters, the light emitted by the shield is distinguished from the light arising from the core scintillator. (auth)

14499 ABSORPTION MEASUREMENTS ON A PLASTIC SCINTILLATOR. Robert J. Potter (Univ. of Rochester, N. Y.). Rev. Sci. Instr., 32: 286-8(Mar. 1961).

The absolute absorption coefficient of a commercial plastic scintillator was measured as a function of wavelength over the region of its luminescence. The absorption coefficient was found to be quite small ($\sim 10^{-3}$ cm^{-1}) through most of the visible spectrum with strong absorption beginning at about 4000 A. The details of the experimental apparatus and the procedure are described. Some interpretations of the absorption properties are offered. (auth)

14500 INSTRUMENT TO MEASURE DENSITY PROFILES BEHIND SHOCK WAVES. W. J. Witteman (Univ. of Maryland, College Park). Rev. Sci. Instr., 32: 292-6 (Mar. 1961).

An optical method for the quantitative study of the density distribution behind shock waves was developed. The method, which uses a photoelectric recording, is based upon the integrated schlieren method originally devised by Resler and Scheibe. A detailed theoretical analysis is given. Excellent agreement with predicted performance was found in measurements of the density profiles behind shock waves in CO_2. The method is very accurate and retains its high sensitivity for weak shocks. The pictures obtained show a nearly exponential approach to equilibrium of the density behind shock waves. (auth)

14501 OPTICAL CHARACTERISTICS OF A MECHANICAL NEUTRON MONOCHROMATOR WITH HELICAL SLOTS. D. Bally, E. Tarina, and P. Pirlogea (Inst. of Atomic Physics, Bucharest). Rev. Sci. Instr., 32: 297-303(Mar. 1961).

The expression of the function $f(\lambda)$ defining the transmission of a mechanical monochromator with helical slots when the incident neutron beam is limited by a Soller collimator was calculated. The influence of the total reflection from the collimator walls upon the function $f(\lambda)$ was also studied. A mechanical monochromator with helical slots, devised for the suppression of the higher-order Bragg reflections from a crystal, is described. Measurements with this monochromator have served to check the calculations. (auth)

14502 MEASUREMENT OF NANOSECOND SCINTILLATION DECAY TIMES. H. Dreeskamp, A. K. Ghosh, and Milton Burton (Univ. of Notre Dame, Ind.). Rev. Sci. Instr., 32: 304-7(Mar. 1961).

An experimental method for measuring scintillation decay times of the order of nanoseconds is described. The method involves a repetitive time selection technique; i.e., in a sense, it is the electronic equivalent of the original Becquerel phosphoroscope. The complete circuitry is shown and some illustrative results are given. (auth)

14503 HIGH PRESSURE ELECTRICAL RESISTANCE CELL, AND CALIBRATION POINTS ABOVE 100 KILOBARS. A. S. Balchan and H. G. Drickamer (Univ. of Illinois, Urbana). Rev. Sci. Instr., 32: 308-13(Mar. 1961).

A high pressure electrical cell is described consisting of tapered Carboloy pistons supported by a pyrophyllite pellet. The pistons are heavily work hardened. A calibration is obtained based on the barium transition at 59 kb, the bismuth transition at 90 kb, and an extrapolation of Bridgman's data. The pressure range is to 500 kb under favorable circumstances. New fixed points include a discontinuous rise in resistance of lead at 161 kb, a discontinuous rise in resistance of barium at 147 kb, a discontinuous rise in the resistance of rubidium at 193 kb, a maximum in the resistance of calcium at 370 to 75 kb, and a maximum in the resistance of rubidium at 425 kb. In addition, there is a discontinuous rise in resistance of iron at 133 kb which is consistent with the shock wave pressure point found at 131 kb and 37°C. (auth)

14504 ANALYSIS OF "IMMERSED" THERMOCOUPLE ERROR. J. E. Bauerle (Westinghouse Research Labs., Pittsburgh). Rev. Sci. Instr., 32: 313-16(Mar. 1961).

The error of an "immersed" thermocouple due to heat leaks through the thermocouple wires was estimated by means of a simple model. The error is shown to decrease exponentially with quantity L_1/l_1, where L_1 is the "immersion" depth of the thermocouple and l_1 is a characteristic length depending on thermocouple parameters and the mode of heat transfer. It is shown that large errors generally arise if such a thermocouple is used in vacuum. Calculations for specific cases are given. (auth)

14505 APPARATUS FOR METHANE SYNTHESIS FOR RADIOCARBON DATING. A. W. Fairhall, W. R. Schell, and Y. Takashima (Univ. of Washington, Seattle). Rev. Sci. Instr., 32: 323-5(Mar. 1961).

A simple apparatus is described whereby any quantity of CO_2 up to several moles can be converted to methane in one step by catalytic hydrogenation using a ruthenium catalyst. The conversion is very rapid, the entire operation being carried out in about 3 hours. The over-all yield is greater than 98%, and the methane is of high purity. (auth)

14506 PROTON-PROTON SPECTROMETER. K. Murray (U. S. Naval Research Lab., Washington, D. C.). Rev. Sci. Instr., 32: 347-50(Mar. 1961).

A detector system is described which can be used to observe protons in the energy range 2 to 10 Mev, with a discrimination factor against γ-ray background greater than 100 to 1 for γ-ray intensities less than 10^3/sec entering the scintillator. The instrumental linewidth of the detector is about 7% for 5-Mev protons. (auth)

14507 ACCURATE LOW LEVEL CURRENT SOURCE. William K. Brookshier (Argonne National Lab., Ill.). Rev. Sci. Instr., 32: 359-60(Mar. 1961).

The adaptation of standard techniques to operational amplifiers resulted in the construction of current sources capable of supplying currents down to 10^{-13} amp with stabilities of 0.1%. Such sources were used for checking the current sensitivity of various devices and, in conjunction with a vibrating-reed electrometer, were used for direct measurements of resistance to 10^{13} ohms. A description of the current source is shown. (N.W.R.)

14508 FAST SWEEP CIRCUIT FOR FOUR-GUN OSCILLOSCOPE. Sheldon Penman (Univ. of Chicago). Rev. Sci. Instr., 32: 360-2(Mar. 1961).

The circuit described is a buffer amplifier to drive the 4-gun deflection circuits from the oscilloscope sweeps. The circuits' gain is adjusted so that sweep speeds on the 4-gun correspond to the time settings on the oscilloscope. Hence, the 4-gun tube can still be used at slower sweep speeds when the scope is used only to store pulses from large counter arrays. The fastest sweep is 10 nsec/cm. By simple modification, higher sweep speeds can be achieved, but at a sacrifice in stability and linearity. (N.W.R.)

14509 NONDISPERSIVE X-RAY SPECTROANALYSIS WITH FILTER AND PROPORTIONAL COUNTER. Takashi Tanenura (Rigaku-Denki Co., Ltd., Tokyo). Rev. Sci. Instr., 32: 364-6(Mar. 1961).

An ingenious pulse analysis method reported by Dolby, Proc. Phys. Soc. 73, 81(1959), was applied to x-ray fluorescence analysis. Adjacent elements are resolved with an accuracy of several percent. Material with an absorption

edge between the characteristic K lines of elements Z and Z + 1 was used as a filter to eliminate the K line of element Z + 1. High intensity and good resolution were obtained with good accuracy and reproducibility, because the results to be obtained are not sensitive to pulse height drift and fluctuations. Two groups of specimens containing two neighboring elements were examined. One group consists of Cu-Zn alloys another mixtures of Al_2O_3 and SiO_2. (N.W.R.)

14510 CORRECTION FOR NONLINEARITY IN X-RAY COUNTING SYSTEMS. R. D. Burbank (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instr., 32: 368-70(Mar. 1961).

By using a single absorber of uniform thickness the ratio I_1 to I_0 is measured at several counting rates, where I_1 and I_0 are the measured intensities of the transmitted and incident beams. In the nonlinear range the ratio increases because of counting losses. A technique using the relation $I_1 + I_1^{loss} = (I_0 + I_0^{loss})R_c$, where I_1^{loss} and I_0^{loss} are the counting losses incurred in measuring I_1 and I_0 and R_c is the constant value of the ratio of I_1 and I_0 that is obtained when there are no counting losses, is employed for correcting the nonlinearity of x-ray counting systems. (N.W.R.)

14511 IMPROVED PUREX DEMOUNTABLE PHOTOMULTIPLIER REFRIGERATOR. Robert M. St. John (Univ. of Oklahoma, Norman). Rev. Sci. Instr., 32: 370-1(Mar. 1961).

An improved refrigerator constructed of Pyrex glass is described. This refrigerator is designed to keep a photomultiplier tube at the temperature of liquid air and in a vacuum. (N.W.R.)

14512 A CO_2-PROPORTIONAL COUNTER OF SMALL VOLUME AND HIGH EFFICIENCY FOR LOW LEVEL β-COUNTING. Marisa Alessio (Universita, Rome), Lucia Allegri, and Francesco Bella. Ricerca sci., 30: 1960-2 (Dec. 1960). (In English)

The counter described has the following characteristics: a background of 2.40 cpm; a counting rate for modern carbon of 10.43 cpm; and an efficient volume of 0.570 l. It is used mainly for radiocarbon dating. Shielding is accomplished by 27 cm of iron and blocks of paraffin mixed with boric acid. The hard component of cosmic radiation is anti-coincidenced by means of 18 Geiger counters. (T.F.H.)

14513 THE CO_2-PROPORTIONAL COUNTER OF THE CARBON-14 DATING LABORATORY OF THE UNIVERSITY OF ROME. Francesco Bella (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome), and Cesarina Cortesi. Ricerca sci., 30: 1969-77(Dec. 1960). (In English)

A carbon dioxide-proportional counting system is described. The preparation and purification of CO_2 is carried out following the De Vries method with a few modifications. The proportional counter presents some original constructive characteristics. The background is 1.75 cpm; the counting rate for modern carbon is 12.08 cpm; the efficient volume is 1.580 liters. The shields are 27 cm thick blocks of iron and blocks of paraffin mixed with boric acid. The hard component of cosmic rays is anticoincided by means of a plastic scintillator. (auth)

14514 A NEUTRON SPECTROMETER IN THE ENERGY RANGE OF 0.7–3 Mev. O. F. Nements and M. V. Pasechnik. Trudy Ses. Akad. Nauk Ukrain. S.S.R., po Mirnomu Ispol'zovan. At. Energ., 84-93(1958).

A fast neutron spectrometer (0.7 to 3 Mev) is designed according to the principle of recording the recoil nuclei from elastic neutron scattering. A spherical ionization chamber with 7.5 cm diameter is used as detector; it operates on the basis of electron collecting. The chamber is filled up with a mixture of hydrogen (1 atm) and argon (3.75 atm). The dimensions of the chamber, the gas pressure, the stopping power of the gases filling up, and the voltage fed to the chamber are chosen according to the condition of minimum pulse amplitude straggling. The pulses from the chamber are fed to a linear amplifier consisting of a preamplifier and a main amplifier; the latter yields output pulses of amplitudes up to 90 v. The signal from the amplifier is fed to a 50-channel amplitude analyzer, which operates on the principle of the amplitude-time transformation. The block-diagram of the unit is presented and the main operation characteristics of the analyzer are considered. The linearity of the amplifier characteristic and the operation stability of the analyzer are checked by means of both a specially produced pulse generator and the pulses from uranium α-particles. The neutron spectrum from the $D(d,n)He^3$ reaction is presented. The resolving power of the spectrometer amounts to 130 kev in the neutron energy range from 0.7 to 3 Mev. (TCO)

14515 A NEW PHASE FLUOROMETER. H. G. Kloss and G. Wendel (Physikalische-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Z.Naturforsch., 16a: 61-6(Jan. 1961). (In German)

A phase fluorometer for electron beam excitation was described. The introduction of a new method for the measurement of the phase difference between excitation and emission permits measurements with a high modulation frequency of the decay times in the range from 5×10^{-10} to 2×10^{-8} sec with an accuracy of more than 10%. Measurements can also be made on weakly luminating materials. The decay time of air was measured at $6.0 \pm 0.4 \times 10^{-10}$ sec. Measurements are reported on the variation of the decay time of some organic phosphors under electron bombardment. (tr-auth)

14516 THE BOUNDARY OF PENETRATING PLASMA AND FOCUSING OF PLASMA. M. D. Gabovich, L. L. Pasechnik, and L. I. Romanyuk (Kiev Inst. of Physics). Zhur. Tekh. Fiz., 31: 87-93(Jan. 1961). (In Russian)

A probe method for determining the boundary of penetrating plasma in an electrostatic lens field is described. It is shown that it is possible to construct a plasma boundary configuration conducive to ion focusing at the plasma surface. (tr-auth)

14517 THE MEASURE OF ELECTRON CONCENTRATION BY MEANS OF INTENSITY OF CONTINUUM OF SPARK DISCHARGE PLASMA. A. A. Mak. Zhur. Tekh. Fiz., 31: 94-9(Jan. 1961). (In Russian)

Electron concentrations of $\sim 10^{19}$ cm^3 in a helium plasma were measured on the basis of bremsstrahlung and recombination radiation intensities. The results are correlated with data on concentration determination by the broadening and shift of the He II 4686 A line. Particle interactions in dense plasma were taken into consideration in determining the concentration by line broadening. (tr-auth)

14518 ISOTERMIC γ-CALORIMETER. A. P. Komar and Z. Kovarzh (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 116-24(Jan. 1961). (In Russian)

The construction, specifications, and performance of an isothermal calorimeter filled with liquid nitrogen are described. The automatic control of the device is described, and measurements of γ flux from a synchrotron target at $E_{\gamma\,max} = 85$ Mev are tabulated. (R.V.J.)

14519 MEASUREMENTS OF ENERGY LOST IN PLASMA BY MEANS OF BOLOMETER METHOD. L. L. Gorelik and E. A. Lobikov. Zhur. Tekh. Fiz., 31: 125-7 (Jan. 1961). (In Russian)

Studies of the ohmic heating of deuterium plasma indicate that only a small part of the joule heating is spent on plasma temperature increase, the rest compensates for energy losses. The time distribution of plasma energy losses was studied with a specially constructed thermoresistance bolometer. Measurements were taken of energy losses in a toroidal discharge chamber at the point where the longitudinal field H_z = 300 gauss, maximum current discharge 40 ka, electric field intensity 1.7 v/cm, hydrogen pressure 3 to 4×10^{-3} mm, and discharge time τ = 0.55 sec. Experiments with the bolometer established the time relation in plasma energy losses and the mean energy accumulated by plasma particles at arbitrary moments of time. (R.V.J.)

14520 AN INCREMENTAL METHOD OF DERIVATIVE POLAROGRAPHY. J. Glickstein, S. Rankowitz, C. Auerbach, and H. L. Finston (Brookhaven National Lab., Upton, N. Y.). p.183-97 of "Advances of Polarography." New York, Pergamon Press, 1960. (BNL-4215)

An incremental polarograph was developed which yields a close approximation to the derivative of the current–voltage curve. The instrument records the current response, Δi, to a small fixed increment of potential, ΔE. Current readings are automatically stored at a definite time in the life of each drop, and ΔE is added shortly after each storage operation. Thus, each drop grows with a given potential. The incremental polarograph is more closely related to the derivative instruments than to alternating voltage polarographs, since it responds to the slope of the current–voltage curve rather than to the impedance of the double layer. Its essential features are illustrated schematically. (auth)

14521 MEASUREMENT OF NEUTRON FLUX AND SPECTRA FOR PHYSICAL AND BIOLOGICAL APPLICATIONS. Recomendations of the National Committee on Radiation Protection and Measurements. Handbook 72. (National Bureau of Standards, Washington, D. C.). 1960. 98p.

The measurement of neutron flux and spectra is discussed, various methods are compared, and results of intercomparisons are given. Methods of measurement are discussed for the emission rate of radioactive neutron sources, thermal neutron flux, intermediate neutron flux, fast neutron flux, and neutron energy spectra. Neutron radiation instruments for area survey and personnel monitoring involving flux and spectrum measurements are included. Typical spectra of various neutron sources are shown. (auth)

14522 METHOD AND APPARATUS FOR MEASURING THE THICKNESS OF A DEPOSIT. (to Commissariat à l'Énergie Atomique). British Patent 859,153. Jan. 18, 1961.

A method is given for measuring the thickness of deposits, whereby the deposit is irradiated by electrons or beta rays, and x rays emitted by the deposit are detected as a function of the thickness. This method is a modification of that in Patent No. 816,062 to permit use with support and deposit metals having atomic numbers less than ~40 and differing from each other by only 2 or 3 units. In this method, the beta rays backscattered by the deposit are eliminated from the x rays by a magnetic field, and the x rays are detected by a gas-filled proportional counter. In the case of deposit and support metals having atomic numbers close together, the x rays emitted by both can be distinguished by means of a thin metallic film positioned in front of the counter. (D.L.C.)

14523 IMPROVED RADIATION DETECTOR. (to Minneapolis-Honeywell Regulator Co.). British Patent 861,717. Feb. 22, 1961.

An electronic apparatus for use as a fire or flame detector is designed so that the background count discriminated against and a shorter time constant can be used, giving faster detection. The apparatus is comprised of a Geiger-Mueller tube type sensor arranged in a circuit to produce a pulsating signal when exposed to ionizing radiation characteristic of the detected condition. The sensor is connected by two signal paths (one of which includes a network that integrates the signal pulses relatively to those in the other path) to an amplifying circuit arranged to respond only when signals are received simultaneously through the two paths. (D.L.C.)

14524 IMPROVEMENTS IN OR RELATING TO AMPLIFIERS. Frank Herbert Wells (to United Kingdom Atomic Energy Authority). British Patent 862,480. Mar. 8, 1961.

An amplifier whose output is proportional to the logarithm of the input voltage is designed for the amplification of voltage pulses. The amplifier comprises a plurality of cascade-connected stages of equal gain arranged to limit with equal input voltages, each state including two valves connected in a longtailed pair circuit. (D.L.C.)

14525 CONTROL EQUIPMENT FOR AN INSTALLATION UNDER PRESSURE. (to U. S. Atomic Energy Commission). French Patent 1,208,454. Feb. 24, 1960.

Pressurizers are described for installations using fluids under pressure. An example is given of a nuclear reactor cooled by a liquid whose temperature is higher than the boiling temperature under atmospheric pressure. The pressurizer equipment includes a container that is in communication, on one hand, with the heat exchanger entrance of the reactor via a throttle device, and on the other hand, with the heat exchanger exit via a control pump, such that the pressure in the container is always lower than the pressure in the reactor coolant circuit. The delivery of the pump is controlled by variations of pressure or temperature in the reactor coolant. (NPO)

14526 DETECTOR FOR THE ESCAPE OF IONIZING FLUIDS. (to Commissariat a l'Energie Atomique). French Patent 1,213,532. Apr. 1, 1960.

Equipment for detecting the escape of heavy water is described. A permeable organ is utilized that is in contact with the space into which the heavy water may escape, the organ being impregnated with a hygroscopic salt and connected to the two terminals of a voltage source. This organ forms an electrical resistance varying with the humidity. The water absorbing permeable organ envelops the electrode of one of the terminals; the electrode of the other terminal has the same electric potential as the heavy water installation. The electrical resistance of this organ depends on the volume of the space and the amount of heavy water that has escaped. (NPO)

14527 FRACTIONATING PLUVIOMETER. (to Commissariat à l'Energie Atomique). French Patent 1.215.107. Nov. 16, 1959.

A pluviometer (rain gage) is described for fractionating precipitation after a predetermined program, e.g., for fallout studies. (NPO)

14528 METHOD AND EQUIPMENT FOR THE DETECTION OF A NEUTRON FLUX. (to The Plessey Co., Ltd.). French Patent 1,222,219. June 8, 1960.

In order to measure the distribution of the neutron flux in a nuclear reactor, an ion chamber is inserted into it. This chamber can be moved along a vertical channel in-

de the reactor, so as to determine the neutron flux distribution along this channel. The ion chamber comprises vo coaxial cylinders forming the electrodes, the outer ylinder forming also the outer casing of the device. The arrow space between the cylinders is filled with a suitble gas. In this gas current-producing ions arise as a esult of radiation emitted, under the influence of the neuron flux, by e.g., fissile materials layered on the elecodes. The ion chamber may be suspended by a flexible oaxial cable comprising a conductor core inside a conentric layer of woven silica, this combination being covred by a woven metallic hose. (NPO)

14529 EQUIPMENT FOR THE MEASUREMENT OF EUTRON FLUX DENSITIES. (to American Radiator and tandard Sanitary Corp.). French Patent 1,223,057. une 15, 1960.

This equipment includes a thermally insulating barrier, ith the hot junctions of one or more thermocouples being rranged on the surface at one side of this barrier, and the old junctions being disposed in the same manner at the ther side. The hot junctions are in contact with a layer of material in which neutron induced fission or disintegraion may arise, so that the heat flux crossing the barrier s proportional to the neutron flux and to the temperature ifference between the hot and the cold junctions of the hermocouples. This temperature difference creates a hermoelectric voltage, which can be measured by a suitble instrument. (NPO)

Materials Testing

14530 (WADD-TR-60-155) DEVELOPMENT OF METHODS AND INSTRUMENTS FOR MECHANICAL EVALUATION OF REFRACTORY MATERIALS AT VERY HIGH TEMPERATURES. D. H. Fisher, D. N. Gideon, J. M. McClure, H. J. Grover, R. L. Carlson, and G. K. Manning (Battelle Memorial Inst., Columbus, Ohio). Mar. 7, 1960. Contract AF33(616)-6155. 75p. (AD-243123)

A mechanical-testing system was established which is capable of providing tensile and compressive stress-strain data and shear-strength data up to 4000°F in vacuum. The results of an evaluation of the system using a molybdenum-0.5% titanium alloy in the bar form are presented. Tension, compression, shear, and bearing tests were conducted at temperatures up to 3500°F. A detailed description of the testing system and specimen designs is presented. An optical strain-measurement system which permits displacements to be measured directly in the gage section is described. With the objective of developing equipment and techniques for use to 6000°F or higher, problems to be solved in order that accurate data will be obtained are considered. Recommendations are made concerning furnace design, temperature and strain measurement, and specimen, grip, and loading design. In particular, the probable advantages of graphite heaters coated with tantalum carbide are pointed out; plans for experimental investigations and a description of apparatus built to study carbide coatings are presented. The further investigation of two-color pyrometry was also recommended. (auth)

14531 (WAL-TR-830.4/1) THE GRAIN SIZE DISTRIBUTION IN METALS AND ITS INFLUENCE ON ULTRASONIC ATTENUATION MEASUREMENTS. Emmanuel P. Papadakis (Watertown Arsenal Labs., Mass.). Feb. 1961. 18p. (PB-171472)

A transformation was derived relating the number of spheres of a certain radius R per unit volume to the number of circles smaller than a certain radius r per unit area appearing on a plane cutting through the volume. The transformation was applied to several hypothetical grain size distributions for polycrystalline metals to find the resulting hypothetical area distribution of grain images on photomicrographs. Comparison of the hypothetical area distributions to experimentally found area distributions gave the following conditions that the true volume distribution of grains must meet: it must be finite at R = 0, and it must have a non-zero decreasing tail for large values of R. The common assumption of a single grain diameter is insufficient to explain the experimental area distribution of grain images. The functions $N_V(R) = R^n \exp(-kR)$ and $N_V(R) = \exp[-(\ln R/R_0)^2/2\sigma_V^2]$ were judged plausible for the volume distribution function of grains, and a correction was computed for the attenuation formulas for Rayleigh scattering of ultrasonic waves in polycrystalline metals by taking averages of R^6 and R^3 over these functions. (auth)

14532 (SCL-T-359) RESULTS OBTAINED WITH AN ELECTROSTATICALLY EXCITED EXTENSOMETER (ELASTOMETER). R. Cabarat. Translated by Marcel I. Weinreich from Mem. sci. rev. met., 56: No. 2, 144-50 (1959). 21p.

A discussion is given of a method used to study the variations of the elasticity modulus of a test rod as a function of temperature. The elasticity modulus can be determined from F_0, L, and Δ; the frequency of the rod vibrations, the rod length, and the rod density, respectively. Several studies are described to demonstrate the accuracy and sensitivity of the measuring method. The results include measurements for: aluminum-copper alloys, ferromagnetic alloys, the influence of the form of graphite on the internal friction of castings or melts, and the anisotropy of elastic properties of gallium monocrystals. Resonance curves are given showing the amplitudes and frequencies for glass and plexiglass. (B.O.G.)

14533 MACHINES FOR THE TECHNOLOGICAL TESTING OF MATERIALS WITH NUCLEAR RADIATION. H. Bühler and W. Schreiber. Atomkernenergie, 6: 63-7 (Feb. 1961). (In German)

The testing of the property change of raw materials by nuclear radiation gains increasing significance through the progressive development of nuclear reactor technique. If these raw materials are used in a nuclear reactor, they are activated, that is, they themselves emit nuclear radiation which excludes in many cases a traditional raw material test due to the biological radiation danger. Therefore, special provisions must be made for the protection of the personnel against irradiation when raw materials are to be tested. The machines for testing the raw materials must be adapted for remote control, and the measured values must be relayed from the area of the nuclear radiation. Machines of German make for the performance of technological raw materials tests, which correspond to these requirements, are described. A universal testing machine for pull, pressure, and bending tests, the traditional model of which was equipped with electronically operating guiding elements, was remodeled in such a way that the control and indication sets for the measured values could be installed separately from the actual testing machine. A hardness testing set for Brinell, Vickers, and Rockwell tests which requires an additional TV installation for the relay of the measured values was also equipped for remote control handling. Furthermore, a small-load hardness testing set with protection device against radiation is described. (auth)

14534 TESTING FOR LEAKAGE IN CONTAINERS FOR RADIOACTIVE MATERIAL. F. Kuhn (Staatliche Materialprüfungsamt Nordrhein-Westfalen, Dortmund, Ger.). Atompraxis, 7: 16-17(Jan. 1961). (In German)

Some problems which arise in testing radioactive preparations in containers for leaks are discussed. Complete specifications for such tests were not yet available at the time the manuscript was finished. (auth)

14535 FATIGUE TESTING AND ANALYSIS OF RESULTS. W. Weibull. New York, Pergamon Press, 1961. 315p. $11.75.

Methods of fatigue testing in metals are discussed and detailed. Fatigue-testing machines and equipment are examined. Instruments and measuring devices are investigated, as are the design, preparation, measurement, and protection of test pieces. Systematic studies are made of factors affecting test results, planning of test programs, and presentation and analysis of results. (T.F.H.)

14536 (A/AC.82/G/L.508) REPORT ON MEASUREMENTS OF MAN-MADE AIRBORNE RADIOACTIVITY IN GY AND IGC, 1957–1959. Josef Podzimek (Ceskoslovenska Akademie Ved. Geofysikalni Ustav, Hradec Krapve). 12p.

Measurements were made of the artificial radioactivity n the air, precipitation, and fall-out in Czechoslovakia. Measurements were carried out during 1957 to 1959. Methds used in the collection and analysis of samples are decribed. Data are presented graphically. (C.H.)

14537 (HASL-111) FALLOUT PROGRAM. Quarterly Summary Report [for] December 1, 1960–March 1, 1961. Edward P. Hardy, Jr., Joseph Rivera, and Robert Frankel New York Operations Office. Health and Safety Lab., AEC). Apr. 1, 1961. 212p.

Data that have become available during the period December 1, 1960 to March 1, 1961 are presented. Radionuclide levels in deposited fall-out, and in air, water, milk, wheat, bread, and other foods are given in tabular form. Interpretive reports, dealing with atmospheric and fall-out radioactivity measurements and analytical errors in the strontium program, are included. Finally, a bibliography of recent literature is presented. (auth)

14538 (NP-9887) STUDY ON INTENSITY OF SURFACE PRECIPITATION USING RADAR INSTRUMENTATION. Quarterly Technical Report No. 9, April 1, 1960–June 30, 1960. E. A. Mueller and G. E. Stout (Illinois. State Water Survey, Urbana). Contract DA-36-039-SC-75055. 21p.

A study was made of the utility of radar equipment in measuring surface precipitation and to improve radar techniques in measuring precipitation for application by the Army to radioactive rainout prediction, trafficability, and communications. A total of 34 rolls of raindrop camera film was received from the three overseas installations. The Majuro installation was dismantled and returned June 3, 1960, to Illinois for refurbishing and reinstallation. Operations at the other locations–Indonesia and Alaska–were satisfactory. A total of 27 of these rolls of raindrop data film was measured during the quarter. The preliminary calculation of the radar variables was accomplished as the film was measured. Preliminary data from Oregon indicated that the size of the raindrops are smaller there than in Miami or Illinois. (auth)

14539 (NP-9888) STUDY ON INTENSITY OF SURFACE PRECIPITATION USING RADAR INSTRUMENTATION. Quarterly Technical Report No. 10, July 1, 1960–September 30, 1960. E. A. Mueller and G. E. Stout (Illinois. State Water Survey, Urbana). Contract DA-36-039 SC-75055. 42p.

The utility of radar equipment in measuring surface precipitation was investigated. A summary of the operation of raindrop cameras is given. Satisfactory operations of one year of raindrop cameras at Miami, Florida; Corvallis, Oregon; Majuro, Marshall Islands; and Woody Island, Alaska were obtained. The means of reducing raindrop data is reviewed. An automatic means of transferring measurements from the projection table to IBM cards was built. Preliminary analysis of the drop data is reviewed. Some results are given from the Miami data. A summary of the problem of rainout is discussed. (auth)

14540 (NP-9956) ON THE GROUND DEPOSIT OF PARTICLES EMITTED FROM A CONTINUOUS ELEVATED POINT SOURCE. PART I: DEPOSIT OF NOMINAL 100μ GLASS MICROSPHERES FROM 15 METERS. Suffield Technical Paper No. 197. K. D. Hage, C. H. H. Diehl, and M. Dudley (Canada. Suffield Experimental Station, Ralston, Alberta). Oct. 18, 1960. 20p.

Data from 9 experiments involving the emission of 100μ glass microspheres from a tower source at 15 m are summarized in tabular form. Estimates of crosswind-integrated ground deposits for all trials were compared with the predictions of a simple fall-out model which neglects the effects of turbulence in the vertical. Within the limitations of the data and of assumptions which are inherent in the model certain conclusions were established from the results. When compared with the observed data in each case the simple fall-out model yielded an overestimate of maximum deposit and a deposit curve which was much to narrow. In each case inclusion of the frequency distribution of horizontal wind speed during the emission period significantly improved the prediction. In certain cases which were characterized by strong inversion conditions or by highly variable wind speeds, the latter predictions were probably within the limits of error of the observed deposits. In the remaining cases further refinements of the model possibly by inclusion of vertical motion or by inclusion of additional contributions to the variance of horizontal wind speed are needed to provide acceptable results. (auth)

14541 (NRL-5567) ATMOSPHERIC SCATTERING IN THE VISIBLE AND INFRARED. J. A. Curcio, G. L. Knestrick, and T. H. Cosden (Naval Research Lab., Washington, D. C.). Sept. 2, 1960. 15p.

The atmospheric aerosol particle-size distribution was examined using experimental spectral scattering coefficients in the wavelength interval 0.40 to 2.27 μ. The results show that the aerosol on a particular day can be represented by a two-component composite distribution, the main component being described by a Junge distribution of the form $dN/d \log r = Cr^{-n}$ and the other by a distribution similar to that of aerosols found in maritime air, or by a relatively monodisperse distribution contained in a narrow radius interval. This study showed that estimates of the aerosol particle size distribution may be in error if based only on attenuation measurements in the visible region. The contribution of the larger particles to the scattering coefficients is not apparent unless the infrared is also investigated. (auth)

14542 (SCTM-194-59(51)) PROGRAM FOR USING A SHEAR FALLOUT MODEL TO RAPIDLY COMPUTE FALLOUT FROM A THERMONUCLEAR BURST. D. A. Young and W. W. Bledsoe (Sandia Corp., Albuquerque, N. Mex.). Nov. 1960. 102p.

A program is described which uses an IBM-704 data processing system to calculate fall-out intensities and doses from a thermonuclear burst. The program also calculates the probabilities of obtaining various intensities and doses

at specified monitoring points, for a given selection of input winds data. The calculations are carried out at a very rapid rate even though a shear fall-out model is used. (auth)

14543 (TID-6567) STRONTIUM-90 ON THE EARTH'S SURFACE. SUMMARY AND INTERPRETATION OF A WORLD-WIDE SOIL SAMPLING PROGRAM. Lyle T. Alexander, Robert H. Jordan, Robert F. Dever (Department of Agriculture); Edward P. Hardy, Jr., Gerald H. Hamada (New York Operations Office. Health and Safety Lab., AEC); Lester Machta and Robert J. List (Weather Bureau, Washington, D. C.). Feb. 1961. 28p.

With the completion of the analyses of soil samples collected in 1959, data are available not only for an evaluation of the total Sr^{90} fall-out in the world, but also for estimating the increments deposited between sampling in 1956, 1958, and 1959. The Sr^{90} data for 1959 are presented together with pertinent data from previous years. (auth)

14544 (TID-6950) HIGH DILUTION ON-STREAM ISOTOPIC TRACERS. Second Quarterly Progress Report [for] May-August, 1960. (Johnston (William H.) Labs., Inc., Baltimore). 79p. Contract AT(11-1)-650 No. 9.

Experimental work is reported on the development of a counter and counting system for psuedo-radiocarbon dating. The system is to be used in identifying the source of organic pollutants in rivers and streams. The contamination activity of the alcoholic extract of organic pollution from the Ohio River was determined. Large-scale, high-dilution tracer applications, in which isotopic tagging is done on a component of the main fluid or stream without subsequent mainline separation, are reported. (W.L.H.)

14545 (TID-12318) ULTRASONIC VELOCITY AND ATTENUATION OF LONGITUDINAL WAVES IN ROCKS. Michel Auberger and John S. Rinehart (Colorado School of Mines Research Foundation, Inc., Golden). July 14, 1960. For Univ. of California. 24p.

Hughes' pulse technique for measuring longitudinal velocities was adapted and extended to measure attenuation of longitudinal waves at frequencies of 250 to 1000 kc/sec. Data for velocity and attenuation in eight different rocks (three granites, one porphyry, two sandstones, one limestone, and one marble) are given at eight frequencies. The values of attenuation measured were found much higher than for metals and plastics in the same range. All curves of attenuation as a function of frequency show one or more peaks, none of the curves indicating a marked law of increase or decrease of attenuation with frequency. In one granite, in the limestone, and in the marble, successive peaks occur at harmonic frequencies. A comparison between the wavelengths for which the peaks occur and the grain size of the rocks shows a good agreement for the coarse-grained rocks between the frequencies of occurrence of the peaks and the resonance frequencies of the largest crystals of the rocks, indicating a very large effect of the frictional boundary losses on attenuation when the wavelength approaches the grain size of the rock. (auth)

14546 (TID-12320) WAVE PROPAGATION IN ROCKS. John S. Rinehart and Jean Pierre Fortin (Colorado School of Mines Research Foundation, Inc., Golden). [1960]. 20p.

Paper presented at Geological Society of America Meeting in Denver, October 31, 1960.

The compressive stress pulse generated in rock surrounding an explosion was investigated. The parameters of the transient disturbance are propagation velocity, particle velocity, particle displacement, and stress. The transmission and reflection of a stress wave at an interface was studied. The mechanism of spalling including generation of multiple spalls is discussed. The partition of stress at boundaries between dissimilar rocks is shown. Critical spalling velocities were computed for several different types of rocks. (M.C.G.)

14547 (TID-12322) DETAILED CHARACTERIZATION OF SOIL AND VEGETATION ON SELECTED SITES TO SERVE AS BASIS FOR FUTURE EVALUATIONS OF EFFECT OF RADIOACTIVE CONTAMINATION. Technical Progress Report for Period March 1, 1960 to March 1, 1961. N. Holowaychuk (Ohio. Agricultural Experiment Station, Wooster). Contract AT(11-1)-414. 150p.

Detailed field and laboratory studies were made on samples of soils from a number of locations throughout Ohio. Data are tabulated on the morphology and physical and chemical properties of profiles sampled to a depth of over 100 inches. The mineral composition of the clay fraction and the chemical properties of the fraction that may influence retention or release of strontium and calcium was studied. Analyses of soil samples and of tree leaf and meadow plant material and studies on the fixation of fall-out fission products in organic matter and microorganisms are reported. A two-crystal spectrometer was developed and used to assay a number of soil and tree leaf samples for gamma emitters. The uptake of Sr^{90} by wheat, rye, and garden beans was investigated in greenhouse studies. (C.H.)

14548 (TID-12333) STUDIES RELATED TO RADIOACTIVE FALLOUT. J. Rosinski and J. Stockham (Illinois Inst. of Tech., Chicago. Armour Research Foundation). [1960]. 22p.

Radioactive fall-out particles were collected during dry weather from July 1958 to November 1959 and classified. The average concentration and size distribution of particulate matter from 1 to 10 μ in diameter were measured concurrently with an ARF single particle counter. The relation between particle diameters and the radioactivity of single particles was calculated. Results indicate that radioactivity associated with dry fall-out is proportional to either particle volume or to the fourth power of the diameter. It was concluded that the radioactivity associated with dry fall-out is an insignificant fraction of the total fall-out radioactivity. Preliminary experiments were also performed to establish the relationship between particle weight and radioactivity. Particles collected in the sampling system were weighed and their radioactivity was determined. Observations on the scavenging of aerosol particles by an evaporating or condensing water droplet were made in a constant-temperature, water-jacketed, glass chamber. A dust-feed apparatus was used to generate aerosol from dry powders. The fraction of particles captured was plotted as a function of the rate of growth of the water droplet. Analysis of the data indicates that particle capture in the presence of a water vapor gradient during condensation is a function of particle size. The effect of the water vapor gradient during evaporation was not well defined. (C.H.)

14549 (TID-12335) THE THERMODYNAMICS OF REACTIONS LEADING TO THE VOLATILIZATION OF URANIUM FROM VOLCANIC SYSTEMS. Final Report. Harold F. Mason (Wisconsin. Univ., Madison). Feb. 1954. Contract AT(11-1)-178. 25p.

The thermodynamics of reactions which might lead to the volatilization of uranium from volcanoes were considered theoretically and experimentally. Mechanisms considered include halogenation and oxidation to UO_3. Calculations based upon data given in or extrapolated from the literature were conducted to ascertain what metal halides, hydrogen

halides, and free halides could halogenate the uranium oxides, U_3O_8 and UO_2. These calculations showed that, under volcanic conditions of temperature and pressure, only $FeCl_2$, $FeCl_3$, $MnCl_2$, $AlCl_3$, and fluorine are effective. Since high concentrations of these substances are probably not present in nature, it appears that practicable means of halogenation are not available. Experimental studies confirmed the order of magnitude of uranium halide vapor pressures predicted by theory. Attempts to generate volatile products by passing oxygen over U_3O_8 at elevated temperatures were unsuccessful. These negative results were supported by estimates based on thermodynamic data given in the literature. No detectable evolution of volatile uranium compounds occurred when uraniferous obsidians were heated. These results consistently indicated that the volatilization of uranium compounds in volcanoes can not be a factor of major importance geologically. (auth)

14550 (TID-12336) TRACER STUDIES OF THE ATMOSPHERE. P. K. Kuroda, L. M. Fry, and H. L. Hodges (Arkansas. Univ., Fayetteville). May 16, 1960. 25p.

The nuclear test suspension period, which lasted for a period of approximately sixteen months starting in November 1958, provided an ideal opportunity to conduct tracer studies of the global movement of air masses. All rainfalls which occurred at Fayetteville, Arkansas, during the period November 1958 through February 1960 were sampled and analysed for Sr^{89}, Sr^{90}, and Ba^{140}. A striking similarity was observed between seasonal variations of ozone and Sr^{90}. The average Sr^{90} content of the stratosphere decreased at a rate corresponding to an apparent stratospheric mean storage time of 12 to 24 months. Topics discussed include the global circulation of air masses, seasonal variation of Sr^{90} concentration in rain, and the interpretation of radioisotope ratio data. The upward flow of air from the troposphere to the stratosphere near the equitorial region was studied following the injection of radioisotopes by the French atom bomb tests in the Sahara Desert on February 13, 1960. Preliminary data are included. (C.H.)

14551 (UCRL-6227) NOTE ON ESTIMATING THE ENERGIES OF THE ARIZONA AND UNGAVA METEORITE CRATERS. Gerald W. Johnson (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 7, 1960. Contract W-7405-eng-48. 16p.

Crater dimensions derived from the high explosive experience of the Plowshare Program were used to estimate "equivalent" depths of burst and energies of the Arizona and New Quebec meteorite craters. Best fit to the Arizona crater is obtained using the following scaling laws: apparent crater diameter = 266 $W^{1/4}$ feet, apparent crater depth = 57 $W^{1/4}$ feet, and effective depth of burst = 25 $W^{1/4}$ feet where W is the energy release in kilotons. From these relationships the energy of the Arizona meteorite was placed at 5 Mt with an effective depth of burst of 210 feet, and for the New Quebec meteorite the energy was 205 Mt with a depth of burst of 540 feet. (auth)

14552 (UCRL-6240) CAVITY DEFINITION, RADIATION AND TEMPERATURE DISTRIBUTIONS RESULTING FROM THE LOGAN EVENT. Walter P. Bennett, Arthur L. Anderson, and Basil L. Smith (California. Univ., Mercury, Nev. Radiation Lab.). Dec. 1960. Contract W-7405-eng-48. 54p.

Following the detonation of the Logan event on October 15, 1958, an exploratory drift was driven to within 160 feet of ground zero to recover experimental apparatus. Several postshot diagnostic holes were drilled through the zone of effects to obtain temperature and radiation data. The data obtained were used to define the cavity and the thermal distribution in the media surrounding ground zero. The following are presented: a graphical representation of drill hole temperature and radiation, isothermal diagram of area surrounding ground zero from which the thermal energy deposited to the media was obtained, cavity definition diagram from which cavity radii and scaling factors were derived, and blast effects encountered during the postshot excavation of the original access drift. (auth)

14553 (AEC-tr-4366) DETERMINATION OF THE VOLUMETRIC GRAVITY OF ROCKS BY MEANS OF GAMMA RAYS. Anton Lungu. Translated from Rev. minelor(Bucharest), 11: No. 1, 16-20(1960).

The absorption of gamma rays in rocks is analyzed from the physical point of view; the photoelectric effect, Compton effect, and pair formation are considered. A scheme for measuring the volumetric gravity of rocks is outlined. A comparison is given of gravity determinations made on various rock types using laboratory and gamma absorption methods. (D.L.C.)

14554 (AEC-tr-4367) QUANTITATIVE RELATIONS IN RADIOMETRIC WORK AT URANIUM DEPOSITS. Anton Lungu. Translated from Rev. Minelor (Bucharest), 11: No. 3, 93-100(1960). 30p. (Includes original, 8p.).

A description is given of the determination of uranium content in ore deposits by determining the γ emission, which is proportional to the concentration. The proportionality equation is: $I = KC$, where I is the γ intensity in $\mu r/hr$, C is the metal concentration in the ore, and K is a proportionality constant which depends on the type of apparatus used, type of counter, type of screen, and the character of the radioactive equilibrium between radium and uranium. An analysis is given of each of the investigational methods used. Correlations between elements of radiometric probing, chemical analysis, and the core sampling curve are illustrated. (B.O.G.)

14555 (JPRS-6838) RADIOACTIVITY IN THE OCEANS, USSR. Mar. 7, 1961. Translated from Vestnik Moskov. Univ., No. 5, 1960. 16p.

Gamma spectrometric measurements were made of the radioactivity of the waters of the Atlantic Ocean. Data were recorded relative to the distribution of radioactive elements by depth at various sites. A scintillation detector was modified for use in the measurements. Data indicate that the contamination was of an atmospheric character, indicating a fall-out origin. Three distinct layers of radioactivity were found within the first 120 m. Characteristics of each are discussed. Results are also included from measurements of the total radioactivity of oceanic waters in the Antarctic sector of the Pacific Ocean. The radioactivity of the region investigated was twice the natural level. Data indicate that the contamination was of an atmospheric character. The most active part of the fall-out products was in the upper mixed layer at a depth of approximately 50 m. Radioactivity decreased between 50 and 150 m. (C.H.)

14556 RADIOACTIVE FALL-OUT OVER SOUTH AFRICA. W. R. McMurray (National Physical Research Lab., Pretoria). Atomics and Energy, 5: No. 8, 9p.(Aug. 1960). Suppl. to Ind. Rev. Africa. (A/AC.82/G/L.556) (In English)

The methods of sampling and measurements of fall-out over South Africa resulting from nuclear weapon testing are presented and discussed. The rate of decay of mixed fission products is analyzed to enable a simple estimation of the effective age of a sample of unknown origin. The data are analyzed to obtain time and space distributions. The South African data are compared with similar infor-

mation available from the Northern Hemisphere. Additional radiation of genetic significance is derived from the measured accumulated environmental contamination and the extent of Cs^{137} ingestion. The latter is estimated from related measurements of Sr^{90} deposition. (auth)

14557 ABSOLUTE AGES OF SEVERAL FRENCH URANIUM MINERALS DETERMINED BY THE LEAD METHOD. Marcel Roubault and Georges L. Durand (Centre de Recherches Radiogeologiques, Nancy, France). Compt. rend., 252: 367-70(Jan. 16, 1961). (In French)

The ages of several uranium minerals were determined. Values obtained by measurement of the ratio Pb^{207}/Pb^{206} were compared with those derived from the ratios Pb^{206}/U^{238} and Pb^{207}/U^{235}. A study of the disagreements between these various ratios (by utilizing the Wetherill method) shows that the uranium minerals considered were formed 260 ± 5 MA (permian) and altered 70 ± 5 MA (beginning of the tertiary) ago. (tr-auth)

14558 THE ROLE OF DETRITUS FORMATION IN THE MIGRATION OF Sr^{90}, Cs^{137}, AND Ce^{144}. EXPERIMENTS WITH THE SEAWEED CYSTOSEIRA BARBATA. G. G. Polikarpov (Sevastopol Biology Station, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 921-3 (Feb. 1, 1961). (In Russian)

Knowledge of the effect of decaying matter on the movement of fission products is of importance in the disposal of fission product wastes at sea. Duplicate experiments were run on a 2.5-liter scale with 10 μc/l of Sr^{90}, Cs^{137}, and Ce^{144} tracers in the presence of the brown algae Cystoseira barbata which is the most common algae in the Black Sea. Since the sea water was not circulated or aerated, the algae began to die in four days and were completely decomposed at the end of the experiment (64 days). Activity measurements on the organic detritus showed that Sr^{90} was almost completely leached from the organic matter by the sea water, but that additional amounts of Cs^{137} and Ce^{144} were adsorbed by the decayed organic residue from the sea water. (TTT)

14559 GEOCHEMICAL AND HYDRODYNAMICAL CONDITIONS FOR THE APPEARANCE OF AN EPIGENETIC URANIUM MINERALIZATION IN OIL-BEARING HORIZONS. A. I. Germanov. Geokhimiya, No. 2: 99-109(1961). (In Russian)

An epigenetic uranium mineralization, associated with the bituminous organic matter of the oil series, sometimes occurs at the edges of artesian, (oil-gas bearing) basins. The hydrodynamic conditions for the formation are considered. (auth)

14560 URANIUM, THORIUM, RADIUM AND IONIUM CONTENT IN THE QUARTERNARY DEPOSITS OF THE RIVER LENA. V. I. Baranov and N. I. Titaeva (Moscow State Univ.). Geokhimiya, No. 2: 110-14(1961). (In Russian)

Data are given on the content of radioactive elements in young continental sedimentary formations of Siberia. Uranium capture from aqueous environment by sediments with a high content of organic matter is ascertained. The enrichment of the sediments in uranium on the background of low thorium, radium, and ionium contents is indicative of the possibility of using the ionium method to ascertain the time of their formation. (auth)

14561 SOME PHYSICO-CHEMICAL PECULIARITIES OF URANIUM BEHAVIOR IN HYDROTHERMAL SOLUTIONS. G. B. Naumov (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 2: 115-32(1961). (In Russian)

The most typical components of uranium-containing hydrotherms are carbon dioxide, silicic acid, fluorine, and sulphur; the most typical cations are alkaline metals. A study of uranium behavior showed transport in the form of complicated complex ions, among which the carbonate and the fluoride ions are the most probable. The processes of complex formation provide a reliable transport of hexavalent uranium under conditions where UO_2^{2+} is reduced to UO_2. On the basis of an analysis of the behavior of complex uranium ions; the principle causes of nasturan deposition were traced. (auth)

14562 ON THE BEHAVIOR OF RARE EARTH ELEMENTS IN FLUOR-BEARING ENVIRONMENT. G. A. Bandurkin (Geochemical Inst., Siberian Section, Academy of Sciences, USSR). Geokhimiya, No. 2: 143-9(1961). (In Russian)

In greysen deposits a close genetic bond exists between rare earth elements, fluor, and such elements as Al, Fe, Zr, Th, Sn, Be, and others. Such a bond may be explained by the formation of complicate fluoride complexes of the $[MeF][TRF_4]_2$ type. Being sufficiently mobile under acid conditions, they desintegrate easily in alkaline conditions. (auth)

14563 DEPOSITION OF FISSION PRODUCT NUCLIDES AFTER TWO SAHARA NUCLEAR TEST EXPLOSIONS. V. Havlovic (Charles Univ., Prague). Nature, 189: 977-8 (Mar. 25, 1961).

The influence of two Sahara nuclear test explosions, on February 13 and April 1, 1960, on the fission product nuclides in the ground-level air in Czechoslovakia was characterized by a slow increase during the second quarter of 1960. The beginning of this increase appeared at the end of February. This observation is in satisfactory agreement with the simultaneous measurements of the radioactivity in fall-out and rain. The increase of fission product nuclides in the ground-level air in the mean monthly values is evident. The mean fission product activity during the second quarter of 1960 was about 320% higher than that during the fourth quarter of 1959. Monitoring methods are described and data are presented graphically. (C.H.)

14564 THE POSSIBILITIES OF NATURAL RADIOCARBON AS A GROUND WATER TRACER IN THERMAL AREAS. G. J. Fergusson and F. B. Knox (Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand). New Zealand J. Sci., 2: 431-41(Sept. 1959).

An evaluation of the factors that affect the C^{14} concentration of the carbon dioxide coming to the surface with water and steam in the thermal areas, shows C^{14} measurements can assist in the study of the underground movement of water. Measurements carried out at five locations in the Wairakei thermal area of New Zealand show that the time for appreciable underground circulation of water in this area is less than 40,000 years for travel from the surface to depths of 1500 ft or more. (auth)

14565 RADON CONTENT OF ATMOSPHERIC AIR AT GIZA. Abdel Fattah El-Nadi and Hassan Omer (Cairo Univ.). Proc. Math. and Phys. Soc. U.A.R., No. 23, 65-9 (June 1959). (In English)

Measurements of radon content in atmospheric air at Giza were carried out during the period January to May 1957. About 150 individual observations were carried out and a mean value of 90×10^{-18} c/cc was obtained. It was found also that rainfall decreases the concentration of radon in air. (auth)

14566 ISOTOPIC COMPOSITION OF XENON FROM ENSTATITE CHONDRITES. J. H. Reynolds (Miller Inst. for

Basic Research in Science and Univ. of California, Berkeley). Z. Naturforsch, 15a: 1112-14(Dec. 1960). (In English)

The xenon isotopic compositions of three enstatite chondrites were determined, and the results were compared with those obtained from other meteorites and with the atmospheric composition. The enstatite chondrites are a rare type of hard, tough stone characterized by the absence of oxidized iron, the presence of carbon, and higher abundances of the heavy elements such as iodine. These chondrites present a uniform xenon spectrum with a very prominent excess of Xe^{129} and with secondary anomalies similar to those found in Richardton and the carbonaceous chondrites. (J.S.R.)

14567 (ARF-3187-1) ELECTROSTATIC CLASSIFICATION OF SUBMICRON AIRBORNE PARTICLES. Progress Report October 15 to December 15, 1960. G. Langer (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Contract AT(11-1)-578. 5p.

In the study of basic variables that affect the electrostatic classification of heterogeneous aerosols in the submission range, basic performance data on the charger was obtained in order to establish optimum charger configuration. The performance of the charger was judged by the classification of a salt aerosol. Results indicated that the average field strength may not be the controlling factor, but that the high field gradient that exists close to a discharger wire is the controlling driving force for the ions charging the aerosol. (M.C.G.)

14568 (CRER-986) RADIONUCLEIDES PRESENT IN COOLING WATER FROM THE NRX REACTOR. W. F. Merritt and Patricia Patrick (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1960. 7p. (AECL-1177).

A study was made of some of the radionuclides present in the effluent cooling water from the NRX reactor at Chalk River. The cooling water was found to contain Mn^{56}(2.6 hr), Na^{24}(15.0 hr), As^{76}(26.7 hr), P^{32}(14.2 day), S^{35}(87.2 day), and possibly Mg^{27}(9.5 min). A sample of "crud" from the cooling water contained Fe^{59}(45 day), Sc^{46}(85 day), Zn^{65}(245 day), Mn^{54}(300 day), and possibly La^{140}(40.2 hr). (auth)

14569 (HW-68751) CONTROL LIMITS FOR THE CONCENTRATION OF RADIOACTIVE MATERIALS IN AQUEOUS AND GASEOUS EFFLUENTS FROM THE PLUTONIUM RECYCLE TEST REACTOR. G. E. Backman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 6, 1961. Contract AT(45-1)-1350. 9p.

Recommendations on the levels of radioactive materials in the effluents from the Plutonium Recycle Test Reactor which shall initiate corrective or emergency action are reviewed and updated. The only potential source of substantial river contamination from the facility is a fuel element rupture accompanied by a sizable leak in the primary coolant system. A trip point was set on each of the monitoring instruments so that full containment of the effluents would be automatically effected if any two of the chamber should indicate that the activity level of the effluent is sufficiently off standard to warrant such action. For aqueous effluent, the most limiting situation was assumed to be the concentration of I^{131} in Columbia River water used for drinking purposes. On this basis full containment should be tripped if the concentration of radioactive materials in the effluent reaches 5 μc/cc. For the selection of the trip point for ventilation containment, radioiodine was again assumed to constitute the greatest hazard. It was calculated that ventilation containment should be automatically executed if the concentration of radioactive materials in the gaseous effluent reaches 5×10^{-2} μc/cc. Levels of radioactivity indicating the need for corrective action but lower than those which would result in full containment were determined and termed "operational guides." (M.C.G.)

14570 (LA-2494) PHOTODOSIMETRY PROCEDURES AT LOS ALAMOS. George J. Littlejohn (Los Alamos Scientific Lab., N. Mex.). Aug. 1960. Contract W-7405-eng-36. 49p.

Photodosimetry methods presently employed at Los Alamos are described. Descriptions of the film types utilized in the brass-cadmium body and wrist badges are presented. Methods of calibrating and evaluating film exposures to x rays, gamma rays, beta rays, thermal neutrons, fast neutrons, and plutonium are given. Techniques and equipment involved in developing, densitometry, and microscopy are described. Methods used in recording and maintaining personnel exposure records by means of IBM equipment are presented. (auth)

14571 (MND-P-2047) HAZARDS SUMMARY REPORT FOR A THREE WATT POLONIUM-210 FUELED THERMOELECTRIC GENERATOR. (Martin Co. Nuclear Div., Baltimore). June 1959. Decl. Sept. 19, 1960. 36p.

A hazards survey was made of the Auxiliary Power Unit (APU) for space vehicle applications. The APU utilizes the decay process from 1570c of Po^{210} to generate thermal energy. The design is described and diagrams are given. The factors involved in the integration of the thermoelectric generator into the Discoverer or Sentry vehicles are discussed. The physical, chemical, nuclear, and radiobiological properties of Po^{210} are given. The shielding requirements for the APU are outlined. The principal environmental hazard is that imposed by the toxicity of the radionuclide fuel when released to the biosphere. Hazards design criteria were determined by extreme conditions including handling accidents, missile vehicle failures, and re-entry through the atmosphere and subsequent earth impact. (M.C.G.)

14572 (MND-P-2048) HAZARDS SUMMARY REPORT FOR A TWO WATT STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR. (Martin Co. Nuclear Div., Baltimore). June 1959. Decl. Sept. 19, 1960. 34p.

A hazards survey was made of the Auxiliary Power Unit (APU) which utilizes the decay products from 8,300 c of Sr^{90} and its daughter, Y^{90}, to generate thermal energy. A diagram and description of the Sr^{90}-fueled APU are given. The location, temperature effects, emergency provisions, and structural requirements involved in the integration of the generator into the Discoverer or Sentry vehicles are discussed. The properties of Sr^{90} are given. Shielding requirements were imposed primarily by weight limitations rather than by a predetermined design dose rate. The radioisotope must be contained under any conceivable condition, operational or accidental, when it is in the biosphere. The most stringent conditions in terms of internal and external mechanical, thermal, and chemical forces serve as design criteria. The hazards design criteria were determined by extreme conditions including handling accidents, missile vehicle failures, and re-entry through the atmosphere and subsequent earth impact. (M.C.G.)

14573 (NP-9928) MODEL STUDIES OF BLAST EFFECTS. VI. AN INVESTIGATION OF THE AIR MOVEMENTS ASSOCIATED WITH THE ENTRY OF SHOCK

WAVES INTO MODIFIED PARAPET TRENCHES. Suffield Technical Paper No. 207. J. C. Muirhead, F. L. McCallum, and D. W. Lecuyer (Canada. Suffield Experimental Station, Ralston, Alberta). Jan. 6, 1961. 15p.

The air movements in $^1/_{10}$ scale Simple and Parapet trenches, and in three modifications of the Parapet trench were examined and compared. Results indicate that some improvement in Parapet trench design can be obtained by steepening the slop of the inside edges of the parapets and by moving them as close as possible to the trench. (auth)

14574 (NYO-9504) RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Annual Progress Report. (Massachusetts Inst. of Tech., Cambridge). May 1960. Contract AT(30-1)-952. 285p. (Tid-11737)

The study of the toxicity of Ra and MsTh(Ra^{228}) in humans was continued. Several Thorotrast cases were also examined. Physical and clinical studies were made on 151 persons. In all cases possible γ ray measurements were made of Ra and MsTh decay products retained in the body, α-ray measurements of Rn and Rn^{220} in breath, a complete medical history was taken, a complete x-ray examination was made of the skeleton, and urinalysis, hematological, and blood chemistry studies were made. Medical data are appended. An extensive intercomparison of Ra burden measurements on living subjects was carried out between M.I.T. and ANL. Results are tabulated. Complete measurements were made of tooth and bone MsTh/Ra ratios on 24 individuals. Comparison of results with data on Ra/Ca ratios of teeth and total skeleton and with data from whole-body measurements on the same individuals led to the conclusion that estimates of total skeleton Ra burden can be made with reasonable accurateness on the basis of data obtained from Ra γ-counting a single tooth. Data are being recorded on punched cards for correlation with the incidence of various affects such as tumors, bone fractures, age at exposure, age at occurrence of effects, and other epidemicological conclusions. Whole-body radioactivity measurements were made on 45 normal employees. Measurements on the half-life of Ra^{228} gave a result of 5.7 ± 0.2 years. Results are summarized from dosimetry measurements, the development of radiation detection instruments and techniques, and miscellaneous related projects. A scintillation-type fast neutron dosimeter based on the Bragg-Gray cavity principle was tested for absolute dose measurements using a Pu-Be neutron source and 2.5 and 14-Mev monoenergetic neutrons obtained from d-d and d-t reactions. Test results are also reported for an instrument designed for storing data in coded form on a magnetic tape loop for later transfer to an analyzer. A list is included of publications during the period. (C.H.)

14575 (RFP-222) EVALUATION OF FILTER FLAMMABILITY AND FILTER BANK FIRE DETECTION SYSTEMS. P. D. Erickson, J. A. Geer, and F. J. Linck (Dow Chemical Co. Rocky Flats Plants, Denver). Feb. 24, 1961. Contract AT(29-1)-1106. 85p.

Burning tests were made in a test plenum containing a sufficient number of filters to simulate conditions which would exist in a large bank containing several hundred filters. Studies were made of flame propagation, fire alarm systems, effectiveness of water sprays, and fire fighting techniques. Flame propagation studies gave information on the burning characteristics of various types of filters and the effect of various operating conditions on the characteristics. Four fire alarm systems were evaluated. All of the alarms operated, although to varying degrees of satisfaction. A smoke alarm performed better than any of the others. Fog-type water sprays were tested and found to be very effective in controlling fires in the initial stages of burning. In the advanced stages of a fire, sprays supplying large quantities of water were hardly more effective for fire extinguishing than were the fog sprays. The fog spray has the advantages that it will penetrate easily into burning filters and will blanket the air with mist to prevent explosions from occurring in the smoke produced. A type of filter construction was developed which reduced the flammability of the filters to nearly that of the noncombustible types. The filter retains the cellulose-asbestos media but substitutes aluminum for the paper separators. (auth)

14576 (WT-768) PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION. Project 8.4-1 [of] OPERATION KNOTHOLE. Elmer H. Engquist (Chemical and Radiological Labs., Army Chemical Center, Md.). Mar. 1954. Decl. Nov. 25, 1960. 66p.

Data are presented on the attenuation of thermal radiation by an oil smoke screen. Smoke generators, calorimeters, and other instruments used in the tests are described. Meteorological data are summarized. Photographs of the smoke screens are included. An analysis of the photographic records shows that a carbon smoke screen, also evaluated, contributed to the attenuation of thermal radiation. It is estimated that the carbon smoke screen reduced the thermal flux incident upon the oil smoke screen by 88% to 6.8 cal/sq cm, and the oil smoke screen reduced thermal radiation from an estimated 6.8 cal/sq cm to 0.8 cal/sq cm under the test conditions employed. (C.H.)

14577 (AEC-tr-4525) INDUSTRIAL HYGIENE ASPECTS OF TRI- AND PERCHLOROETHYLENE. Etienne Grandjean. Translated from Ind. organisation 28: No. 7 (1959). 30p.

The industrial hygiene aspects of tri- and per-chloroethylene, two widely used solvents, are surveyed. High concentrations of these substances in the inspired air lead to narcotic conditions with unconsciousness which may result in death if help is not immediately available. Continuous and daily exposure to vapors of either tri- or per-chloroethylene may lead to chronic disease, manifesting itself primarily in nervous disturbances and brain affections. Continuous exposure of the skin to either of these solvents may entail skin diseases, prominent among which is the hard-to-cure allergic eczema. Proper handling and use of these two solvents in properly designed equipment constitutes the most important single protective measure. In addition it is important to provide adequate ventilation, to educate foremen and workers and to make available protective clothing against skin damage, as well as for physicians to carry out preventative measures. If these precautions are taken, the use of tri- and perchloroethylene can be recommended, particularly as these solvents are outstanding cleaning agents and are neither explosive nor inflammable. (auth)

14578 (AEC-tr-4532) THE BIOLOGICAL DANGER OF C^{14} CONCENTRATION INCREASE AS THE RESULT OF NUCLEAR BOMB EXPLOSIONS. A. M. Kuzin (Akademiya Nauk S.S.S.R.). 1960. Translation of United Nations Report A/AC.82/G/L.413. 5p.

The biological dangers of increased concentrations of atmospheric C^{14} as a result of nuclear bomb explosions are discussed. It is pointed out that C^{14} concentrations in the atmosphere fluctuated during the last millennium to a very limited extent. From 1954 on a rapid increase in the concentration of radioactive carbon in the atmosphere as well as in living organisms was noted. This increase was attrib-

uted to the testing of megaton-size hydrogen and atomic-hydrogen bombs. In 1957 the increase amounted to 8% over 1954 and in 1959 the increase reached 31%. It is estimated that a resumption of nuclear weapons testing would double the 1954 C^{14} level in 4 years, and after 30 years the content in the atmosphere would be 7 to 8 times the previous norm. It is pointed out that the C^{14} content in the atmosphere is reproduced in plants in the same year and that the levels in animals correspond approximately to the levels in plants the year before. It is shown that a large fraction of C^{14} enters directly into the synthesis of desoxyribonucleoprotein (DNP), which plays a leading role in the transmission of hereditary information. Results of studies are reviewed which show that the biological effectiveness of C^{14} in DNP is 9 times higher than that of exterior irradiation. It is concluded that if nuclear explosions are not discontinued the following generation will receive up to 12 mr per year from C^{14}, or the equivalent of an outside gamma dose of 120 to 240 mr per year. After one generation about 12 million people would be affected with serious genetic diseases, and there would be 24 million still births and 48 million embryonic losses. (C.H.)

14579 IONIZATION RADIATION EXPOSURE OF THE POPULATION OF CROATIA. F. Petrovcic and K. Margreitner (Stojanovic Hospital, Zagreb and Central Inst. of Hygiene, Zagreb). Arhiv hig. rada i toksikol., 11: 45-52 (1960). (In Yugoslavian)

Data have been collected on the exposure of the population of Croatia to various sources of ionizing radiation. The main source of exposure is shown to be x ray diagnostic procedures, amounting to 99.72% of the total, and in the total professional exposure it amounts to 91.9%. Other sources of ionizing radiation as applied in medicine were neglected. Owing to some administrative regulations, diagnostic x rays have often been used too frequently and without full justification. It is strongly recommended that in order to minimize radiation exposure of the population stricter medical criteria should be applied in the use of x ray diagnostic procedures. More attention should also be paid to the improvement of x ray installations, the methods for the use of radiation sources, and to adequate radiation safety measures. (auth)

14580 INVESTIGATIONS ON THE WASH-OUT EFFECT IN THE LOWER ATMOSPHERE. R. Reiter (Universität, Munich). Atomkernenergie, 6: 68-74(Feb. 1961). (In German)

At a mountain station and at a valley station in the Bavarian Alps, measurements of the fission product radioactivity in air and precipitation, of the natural radioactivity in air, and of the concentration of aerosol particles were carried out synchronously and continuously. The vertical distance of both stations is 1.1 km; their horizontal distance is 2.5 km. With the help of these measurements studies were made on the change of the radioactivity of the aerosol taking place simultaneously at both stations during precipitation as well as on how the specific fission product radioactivity of the precipitation is increased during the fall from the level of the mountain station to the level of the valley station. The results obtained during the different kinds of precipitation (snow, shower, steady snow, rain shower, and steady rain) have been discriminated and compared with each other. It was found that in the course of almost any precipitation there is a decrease of the fission product radioactivity of the air, which is stronger during snow than during rain, and stronger during rain shower than during steady rain. Not even during a long continued precipitation does the fission product radioactivity in the air go down below an average of 50% of that found before the precipitation has begun. This final value is reached within about one day in the case of steady snow, within about two days in the case of rain shower, and within more than two days in the case of steady rain. The specific fission product radioactivity of precipitation is increased in the course of the downfall. In snow, the increase taking place in the layer between both stations, i.e., in the lowest kilometer of downfall, amounts to 250 to 500% of the mountain station value. The wash out effect of snow shower is smaller than that of snow with big flakes. On the other hand, rain shower has a better wash out effect than steady rain. The increase of the specific fission product radioactivity in rain taking place in the lowest kilometer of downfall averaged only 20% of the mountain station value. The capture of aerosol particles having diameters smaller than 7.5 μ by snow is far better than by rain, which predominantly brings down particles of diameters greater than 7.5 μ. In these studies, no desorption of radioactive particles from solid or liquid precipitation particles into the surrounding air has been suggested. (auth)

14581 INVESTIGATION ON THE PENETRATING EXTERNAL BACKGROUND RADIATION. W. Herbst and G. Hübner (Universität, Freiburg i. B.). Atomkernenergie, 6: 75-81(Feb. 1961). (In German)

Investigations were performed on the penetrating external background radiation in Southwestern Germany, an area with extreme orographical and geological manifestations, through a shield of 1.04 g/cm^2, with the aid of an ionization chamber, of 25 l capacity, operating with an air filling under atmospheric pressure. Measurements were taken especially at salient spots of county seats and at various geologically different places as well as in some apartments. Extreme locations of radiation, such as the slopes of Wittichen in the Black Forest, and a deposit of potassium were included in the measurements. Both the total radiation as well as its terrestrial proportion were taken into consideration. From 1959 to 1960, a decrease of the dose output of 2.7 μr/h, on the average, was observed. A preliminary relationship of dose output to geological areas is presented. A comparative series of measurements with the ionization chamber and with the scintillation counter showed no significant correlation. (auth)

14582 DETERMINING THE PROTECTION VALUE OF BUILDINGS AGAINST FALL-OUT RADIATION. A. Rudloff (Bundesamt für Zivilen Bevolkerungsschutz, Bad Godesberg, Ger.). Atompraxis, 7: 11-15(Jan. 1961). (In German)

A method is described for determining the protection afforded by rooms and basements against gamma radiation from fall-out. The method is explained by means of practical examples. Particular attention is paid to the scattered radiation descending from the ground floor to the basement; as an example shows, this radiation must not be ignored, since it may form the main share of the total radiation in underground rooms. In conclusion, the data issued on the Bikini test of March 1, 1954, are used as a basis for estimating the dosages which accumulate in a basement room during stays of various lengths. (auth)

14583 RADIATION HAZARDS OF MASS MINIATURE RADIOGRAPHY. Conway Don (Ottawa General Hospital and Univ. of Ottawa). Can. Med. Assoc. J., 84: 573-5 (Mar. 18, 1961). (In English)

The radiation hazards to man can be considered as somatic and genetic. The view is advanced that the somatic hazard to individuals from mass miniature radiography is negligible and that the genetic hazard, both to the individual

and posterity, is insignificant. If mass miniature radiography were abolished in Britain and in the United States, the saving in genetically significant dosage would be less than one-thousandth of all the dosage from diagnostic x-rays. If it were abolished in Ontario, the saving in genetically significant irradiation would be equivalent to 15.5 hours of naturally occurring background radiation per annum. (auth)

14584 DESIGN: KEY TO MINIMIZING PLANT RADIATION HAZARDS. PART 2. L. J. Cherubin (Knolls Atomic Power Lab., Schenectady, N. Y.). Chem. Eng., 68: No. 7, 163-6; 168(Apr. 3, 1961).

In the design of a nuclear plant, radiation hazards must be minimized by sound engineering of shielding, remote handling, ventilation, and decontamination facilities. Engineering factors that must be considered in the design of a radiochemical plant are discussed. (C.H.)

14585 ISODOSE CURVES FOR A WHOLE-BODY HUMAN IRRADIATION BY RAYS AT 200 KV. E. P. Malaise (Université, Liège) and J. Guillaume. J. belge radiol., 43: 599-618(1960). (In French)

The aim of total-body irradiation is to give a homogenous dose of ionizing radiation to the whole body. The conditions required for total-body irradiation are obtained with satisfactory approximation by using a 200-kv apparatus. The best technical conditions and the procedures allowing homogenization of isodoses, for the 200-kv technique, are exposed. Under the experimental conditions, it was possible to give homogeneous doses within 30%. (auth)

14586 REMARKS ON ADVANCED COURSE ON PROTECTION AGAINST IONIZING RADIATION. P. Minet. J. belge radiol., 43: 619-30(1960). (In French)

Some problems studied during an advanced course on protection against ionizing radiations at Saclay are reported. The method used for estimating the dose doubling the mutation rate in man and the values of maxima permissible doses are considered. The maximal permissible concentrations for radio-elements are reviewed, protective measures are briefly recapitulated, and the general lines of medical supervision are traced. (auth)

14587 PROTECTION AGAINST RADIATIONS FROM SEALED GAMMA SOURCES. Recommendations of the National Committee on Radiation Protection and Measurements. NCRP Report No. 24. Handbook 73. (National Bureau of Standards, Washington, D. C.). 1960. 77p.

Supersedes H54.

Advantage has been taken of new knowledge and information on maximum permissible levels of radiation exposure for man. The mandatory provisions are limited to those considered absolutely essential for adequate protection. (C.H.)

14588 RADIOLOGICAL HEALTH DATA MONTHLY REPORT, MARCH 1961. Volume II, No. 3. (Public Health Service, Washington, D. C.). 57p. (PB-161371-12)

Data are tabulated on the radioactivity in samples of air, surface waters, milk, and foods collected from various parts of the United States. The bulk of the sampling was done during October 1960, but some data from previous months are included. Results are included on environmental levels of radioactivity in the vicinity of five major Atomic Energy Commission installations during the second and third quarters of 1960. Factors contributing to the occurrence of radionuclide levels in market milk are discussed. Results are included from a survey in Michigan of medical radiation exposure during pregnancy and measurements of the natural Pb^{210} content of man. (C.H.)

14589 THE USE OF A LOW-SPEED COMPUTER FOR SAFEGUARDS ANALYSES. R. R. Haefner (E. I. du Pont de Nemours & Co., Savannah River Lab., Aiken, S. C.). p.111-26 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

Before a reactor is made critical in the United States, a Safeguards Report is prepared for the Advisory Committee on Reactor Safety of the United States Atomic Energy Commission describing the reactor, reactor operation, and an analysis of possible reactor accidents. The parameters of interest are obtained by experiment where possible, and by the use of digital and analog computers for transient responses that cannot be obtained by experiment. The general features of a number of computer programs for an IBM 650 (2000-word, magnetic drum) to compute physics and engineering parameters of importance in the analysis of reactor operation and possible reactor accidents for the Heavy Water Components Test Reactor (HWCTR) at the Savannah River site are given. A program to solve a set of N ordinary differential equations, for $N \leq 30$ is reviewed. A unique feature of this program is the method whereby non-linear equations can be handled with the general program and a minimum of additional programing. This is the basic routine used in all calculations to describe the hydrodynamics and neutronics of the HWCTR for a variety of accidents due to postulated failures in the hydraulic system or due to postulated malfunctions of reactivity control; Programs to obtain reactivity parameters are reviewed. These programs include multigroup diffusion, single-group P_3, and multigroup P_3 approximations to the Boltzmann equation for the transport of neutrons; Programs to determine heat-removal characteristics of fuel elements are also reviewed. These programs are used to determine possible flow instabilities, or to provide input parameters for the program above. (auth)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

14590 (AD-239572) STUDIES ON PHYSICAL AND CHEMICAL MODIFICATION OF PROTEINS FOR THE PREVENTION OF IRRADIATION OFF-FLAVORS IN MEAT. Report No. 5 (Progress) for August 15, 1959—November 14, 1959. A. L. Tappel (California. Univ., Davis). 5p. Project No. 7-84-01-002. Contract DA-19-129-QM-1172. (NP-9080)

Cytochrome c and hemoglobin in solution were irradiated at various doses ranging from 10^5 to 6×10^7 rads and analyzed for damage to the protein. The break-down was determined by estimating the changes in the protein-nonprotein moiety, and also the ammonia, amides, and the carbonyls formed. About 9% nitrogen of cytochrome c and 30% nitrogen of hemoglobin was found in the nonprotein fraction. About the same amount was recovered as ammonia in the case of cytochrome c, whereas hemoglobin was quite resistant to deamination. Very little amide and no carbonyls were detected even at the highest irradiation dose for both these proteins. (auth)

14591 (BMI-1499) INTRINSIC-RADIOTRACER PROCESS CONTROL. James L. McFarling, Peter Gluck, John F. Kircher, and Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Feb. 10, 1961. Contract W-7405-eng-92. 44p.

A discussion of the potential applications of intrinsic radiotracers to industrial process control is presented. The method of control consists of adding to a process stream a radiotracer in the same form as the material to be followed or controlled. Subsequent radioassay of the stream provides the information necessary for control of the operation being performed on the process stream. Various unit operations are discussed and a few specific applications of intrinsic radiotracers are suggested. (auth)

14592 (TID-6985) UTILIZATION OF RADIOISOTOPE EXCITED X-RAY SOURCES FOR THE ANALYSIS OF HIGH Z ATOMS IN LOW Z MEDIA. Quarterly Progress Report for the Period July 15 to October 15, 1960. (Tracerlab, Inc., Waltham, Mass.). Oct. 15, 1960. 11p. Contract AT(30-1)-2538.

A prototype device, possessing the essential characteristics of a final instrument, was evaluated. The results indicate the technique is feasible for the selected application. Preliminary work, including studies of source, self-absorption, and determination of suitable shielding material, is presented. (auth)

14593 IMPROVEMENTS IN SELF-LUMINOUS LIGHT SOURCES. (to U. S. Radium Corp.). British Patent 861, 790. Feb. 22, 1961.

A self-luminous light source is designed which provides a great increase in visible light intensity with ample effective life and safe radiation levels. This source is a body formed with a cavity in which a phosphor layer is disposed and over which a transparent or translucent plate is disposed to form a shallow closed chamber. The chamber is evacuated and then filled with krypton-85 or tritium to a pressure less than atomospheric but sufficient to excite the phosphor to luminescence. The plate is made out of material which is resistant to darkening by radiation and which serves as radiation shielding. Applications of this light source as a sign or marker and as a two-way lantern are discussed. (D.L.C.)

ISOTOPE SEPARATION

14594 (AEC-tr-4419) ON THE DEPENDENCE OF THE SEPARATION EFFORT ON THE COUNTERCURRENT CIRCULATION IN THE GAS CENTRIFUGE. H. G. Hertz and E. Nann. Translated by Kurt H. Quasebarth from Z. Naturforsch., 10a: 170-1(Jan. 1955). 7p. (EP-4422-135-61U).

Martin and Kuhn's calculations of the xenon isotope separation increase from countercurrent circulation in the centrifuge motor were confirmed in experimental studies. Xenon flowed from a supply tank through a centrifuge rotor in such a way that half the gas left the rotor at the top and the other half at the bottom. The enrichment in the isotopes Xe^{129} and Xe^{136} in both currents was measured. The maximum separation occurred at a velocity $u_0 = 2D/r_a$. A plot was made of separation effect vs. running time. The effects of temperature were also studied. (M.C.G.)

14595 (AEC-tr-4528) PERFECTING OF A PROCESS FOR COOLING A GAS IN BITHERMAL ISOTOPIC EXCHANGE. Society for Studies on Obtaining Deuterium. Translation of French Patent 1,178,661, Dec. 15, 1958. 12p.

A process is described for cooling a gas going from a hot reaction vessel to a cold one in an installation for isotopic enrichment by bithermal exchange. Methods for putting the process are outlined. (B.O.G.)

14596 (JPRS-7462(p.13-23)) PREPARATION OF HEAVY WATER. Translated from K'o-shueh Hsin-wen, No. 39, 10-12(Dec. 7, 1959). 14p.

Processes used by various nations in preparing heavy water are described. The processes discussed include electrolysis of water, refining distillation, exchange processes, gaseous chromatographic process, and the water freezing process. The chief method for producing heavy water as a by-product is the separation of heavy water or heavy hydrogen in the manufacture of ammonia from hydrogen and nitrogen. The special processes for preparing heavy water utilize natural water as the source. It was concluded that if heavy water is to be really produced at a low cost, it will be necessary to establish specialized plants solely for the purpose of producing heavy water. It was found to be impossible to obtain heavy water with high concentration by any single process. Some reduction in cost was realized by preparing heavy water by the process of two-temperature exchange between water and hydrogen sulfide. (M.C.G.)

14597 AN ELECTROSTATIC-MAGNETIC SEPARATOR FOR OBTAINING ISOTOPES OF HIGH PURITY. F. A. White, F. M. Rourke, J. C. Sheffield, and L. A. Dietz (Knolls Atomic Power Lab., Schenectady, N. Y.). IRE Trans. Nuclear Sci., NS-8: No. 2, 13-24(Apr. 1961).

The design of a 30-inch radius combined velocity and direction focusing mass analyzer is described. Application of this instrument as a high purity isotopic separator for research in nuclear physics, metallurgy, and semiconductors is also discussed. Brief mention is made of the development of p-n junctions for the detection of singly-charged ions of low kinetic energy. (auth)

14598 ON THE REACTION OF DEUTERIUM OXIDES WITH CATION RESINS. V. P. Meleshko, O. N. Myagkoi, and K. S. Bogatyrev (Voronezh State Univ., [USSR]). Zhur. Neorg. Khim., 6: 9-14(Jan. 1961). (In Russian)

An attempt was made to determine the possibility of enriching dilute solutions of deuterium oxide by utilizing ionites for swelling instead of ion exchange. It was found that during ionite swelling, in water containing deuterium oxide, the deuterium distributes irregularly between the free water and the water bound by the ionite. The bound water contains less heavy hydrogen than the water in the pores and between the resin grains, confirming a postulated lower solubility for electrolytes in deuterium oxide in comparison to light water. The distribution of deuterium oxide in water bound by resin groups has a gradient character. The variation in the D_2O distribution between free and bound water can be utilized in enriched deuterium oxide solutions. (R.V.J.)

14599 METHOD FOR FIXING ISOTOPE SEPARATION BARRIERS IN METALLIC FRAMES. (to Société Le Carbone-Lorraine). French Patent 1.231.209. Apr. 11, 1960.

Diffusion barriers are set in metallic frames, using a polytetrafluoroethylene packing. Three possible settings are represented. (NPO)

14600 ISOTOPE SEPARATION PROCESS. (to Compagnie Française Thomson-Houston). French Patent 1.235.358. May 30, 1960.

The method utilizes countercurrent thermal diffusion of gases through barriers. No details or examples are given. (NPO)

14601 (DEG-Report-287) GROUP CONDENSATION PROGRAMME FOR USE WITH CARLSON DSN/TDC PROGRAMMES (IBM 704). M. E. Mandl and B. M. Segal (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). Jan. 17, 1961. 23p.

A group condensation program was developed to take a multigroup cross-section library in the format suitable for the Carlson DSN/TDC neutron transport theory programs and produce a similar multigroup library with a reduced number of groups. The energy groups of the original library were combined together without splitting to give the required new energy groups. Weighting spectra were given for averaging cross sections. The program was designed to fit into the Carlson programs so that, when suitable, a standard multigroup library can be used as input although a much reduced library is used for the calculation. If required, the program can be used separately to produce a printed record and/or a punched set of cross sections. The machine space required is approximately 1300_8 instructions plus the space required by the original library. The program was not designed to apply to cases with anisotropic scattering. (auth)

14602 (DEG-Report-316) A STATISTICAL APPROACH TO THE ESTIMATION OF DESIGN DATA. A. N. Knowles (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). 1961. 27p.

Estimation of design data from the evidence of one or more tests by using the sampling theories of statistical analysis is discussed. It was assumed that the distribution of the results obtained is normal or Gaussian. In addition to providing an estimate of the mean value of the results, the sampling theory also indicates the degree of confidence with which it may be assumed that the chosen value is the most conservative. Basic formulas were developed. Their applications are illustrated for three cases. (M.C.G.)

14603 (HW-63299) IBM-709 FORTRAN PROGRAMS FOR STEADY-STATE AND TRANSIENT HEAT TRANSFER ANALYSES FOR THE KAPL-120 LOOP. J. E. Hanson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 31, 1959. Contract AT(45-1)-1350. 27p.

Two programs were written for the analysis of the thermal hydraulics encountered in the KAPL-120 fuel-irradiation loop. These programs will permit a rapid evaluation of the thermal hydraulics involved in any foreseeable proposed irradiation. Design changes can be tested to see if flow and inlet and outlet temperatures are beyond the capability of the loop. One program analyzes steady-state heat transfer for various inlet water temperatures and flow rates, and the other analyzes the thermal hydraulics encountered during a 15-sec flow decay. (T.R.H.)

14604 (NYO-9487) SOME PROBLEMS IN LINEAR GRAPH THEORY THAT ARISE IN THE ANALYSIS OF THE SEQUENCING OF JOBS THROUGH MACHINES. Jack Heller (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Oct. 15, 1960. 43p.

The problems of sequencing jobs through machines are discussed in a linear graph framework. The construction of feasible schedules from given technological orderings is related to the construction of transitive graphs from given component graphs. Methods of constructing transitive graphs are given and bounds on the number of different transitive graphs constructed from given components are determined. A recursive convex function defined on the transitive graphs—the job operation completion time and schedule time—is studied. Bounds on the number of different values that the schedule time can attain is obtained. Examples of multiprogramming, flow shop and machine shop scheduling are studied. (auth)

14605 (PAN-187/XII) FLOATING POINT ARITHMETIC FOR DIGITAL COMPUTERS. M. Warmus (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1960. 5p.

Special subroutines are outlined for fixed-point digital computers where dealing with numbers of widely varying size is necessary. The classical solution is based on the representation of numbers, $x \neq 0$, in the form $x = 2^p \cdot z$, where $\frac{1}{2} \leq |z| < 1$ and p is an integer. The proposed solution is based on the transformation: $X = f(x) = (a\ x)/(1 + |x|)$, where $-\infty < x < +\infty$, $0 < a < 1$, $a \approx 1$, $-1 < X < 1$. Introducing the notation, $|\overline{X}| = a - |X|$, and denoting by $X \ddagger Y$, $X \hat{-} Y$, $X \hat{\cdot} Y$, $X \hat{?} Y$ the operations on the numbers, $X = f(x)$, $Y = f(y)$, corresponding to the operations $x+y$, $x-y$, xy, x/y, respectively, then: $X \ddagger Y = (a\ Z)/(|\overline{X}|\ |\overline{Y}| + |Z|)$, where $Z = X|\overline{Y}| + Y|\overline{X}|$; $X \hat{-} Y = X \ddagger (-Y)$; $X \hat{\cdot} Y = (a\ Z)/(|\overline{X}|\ |\overline{Y}| + |Z|)$, where $Z = XY$; and $X \hat{?} Y = X \hat{\cdot} (a\ \mathrm{sgn}Y - Y)$, where $Y \neq 0$. The whole subroutine for the operations is several times shorter than the corresponding classical one. (auth)

14606 (TID-12125) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. SWITCHING CIRCUIT THEORY. PART IV. DATA REDUCTION METHODS. PART V. ILLIAC USE AND OPERATION. PART VI. IBM 650 USE AND OPERATION. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Oct. 1960. Contract AT(11-1) 415. 43p.

High-speed Computer Program. Check procedures are discussed, and the activity of the flow-gating store and the merits of parallel operation by advanced control compared with strict serial operation were studied. The ratio of the inner loops execution time to that in a similar machine without advanced control is ≥0.65; in most of the cases, it fell within 10% of 0.7, although it was 0.94 in the square root program. A racing NOT test unit and a bleeder were built and tested. The present status of programs for auxiliary storage of data is discussed. A run was made with a core memory test model, for which a high error rate was found. The time required to set the selectors and the end connection logic in the MAU are discussed. Circuit Research Program. An attempt was made to find methods for achieving directivity in tunnel-diode circuits without resorting to transistors used in emitter-follower connection. Measurement of transistor parameters for pulse response calculations is considered. Switching Circuit Theory.

Analysis of the program for testing asynchronous circuits was extended to new rules for generation and combination of change paths. Data Reduction Methods. A tracking routine for studying a photograph of a high-energy event in a H_2 bubble chamber is being investigated in order to cut down the input data rate and the amount of time-consuming arithmetic work. Illiac Use and Operation. Three new codes which were added to the Illiac library are given together with descriptions of the problems worked out on the Illiac. The errors occurring in the use of Illiac are analyzed. IBM 650 Use and Operation. Problems used in conjunction with IBM 650 are described, and its errors are analyzed. (D.L.C.)

14607 (TID-12126) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. MATHEMATICAL METHODS. PART IV. SWITCHING CIRCUIT THEORY. PART V. DATA REDUCTION METHODS. PART VI. ILLIAC USE AND OPERATION. PART VII. IBM 650 USE AND OPERATION. PART VIII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Nov. 1960. Contract AT(11-1)-415. 43p.

Discussions on the high-speed computer program include test control design, core storage unit, magnetic drums and tapes, paper tapes, slow circuits, exponent and main arithmetic units, flow charts for arithmetic control, and speed-independent designs. Work done in the circuit research program includes flow-gating systems tests and two-wire low swing circuits. Mathematical methods are described for experiments with a floating-point differential equation solver. Switching circuit theory developments involve simplification techniques for Boolean functions, estimates of the maximum number of prime implicants in Booleans functions of N variables, a formal algebra for linear graphs, and a technique for obtaining all maximum nodal normal subgraphs of a linear graph. Automatic reduction methods are described for bubble chamber photographic data. The operation, programming, and usages of the ILLIAC and the IBM-650 are described. (For preceding period see TID-12125.) (B.O.G.)

14608 (AEC-tr-4311) CONVEX FUNCTIONS AND ORLICZ SPACES. The Contemporary Problems of Mathematics. M. A. Krasnosel'skii and Ya. B. Rutitskii. Translated from a publication of the State Publishing House of Physico-Mathematical Literature, Moscow, 1958. 219p.

A theory is presented on wide classes of convex functions which play an important role in many branches of mathematics. The theory of Orlicz spaces (normed spaces, e.g., L^p) is developed in detail and its application shown. (D.L.C.)

14609 SEPARATION OF HYDROGEN ISOTOPES BY DISTILLING AZEOTROPE MIXTURES OF STRONG ACIDS BY MEANS OF WATER. PART II. EXPERIMENTAL DETERMINATION OF THE ELEMENTARY SEPARATION FACTOR FOR THE AZEOTROPE NITRIC ACID–WATER. K. Wetzel and H. Schütze (Institut für Physikalische Stofftrennung, Leipzig). Isotopentechnik, 1: 46-9(Oct. 1960). (In German)

A considerable hydrogen isotope effect is to be expected on evaporating the azeotrope mixture HNO_3/H_2O. A separation factor $\alpha = 1.059$ is determined for the measurement of the head and sump concentration of the deuterium in a packed column at fixed reflux ratios. The measurements are analyzed by an algebraic method simulated to the McCabe-Thiele method. (auth)

14610 INTEGRAL REPRESENTATION FOR THE NON-RELATIVISTIC COULOMB GREEN'S FUNCTION. Eyvind H. Wichmann and Ching-Hung Woo (Univ. of California, Berkeley). J. Math. Phys., 2: 178-80(Mar.-Apr. 1961).

Although the radial Green's function for the Schrödinger equation in a Coulomb field can be obtained in the usual way in terms of the two linearly independent solutions to the radial equation for a particular angular momentum state, the sum over angular momentum states does not seem to have been carried out. In this note this sum is carried out and a "closed form" obtained in the form of a double integral. The result is believed to be useful for perturbation calculations where the "intermediate states" involve many angular momentum states. (auth)

14611 SOLUTION OF THE EQUATIONS OF STATISTICAL MECHANICS. Robert M. Lewis (New York Univ., New York). J. Math. Phys., 2: 222-31(Mar.-Apr. 1961).

The solution of the initial value problem for Bogoliubov's functional differential equation of nonequilibrium statistical mechanics is obtained. This solution is then expanded in an infinite power series in the density which has the advantage that the calculation of the leading terms requires the solution of s-body problems only for small values of s. A derivation of the equilibrium equations by reduction from the nonequilibrium equation is included. These results are applied to obtain a simple derivation of the Boltzmann equation. (auth)

14612 PERTURBATION FORMULAS FOR THE ENERGY LEVELS OF THE SLIGHTLY ASYMMETRIC TOP. H. L. Davis and John E. Beam (Sandia Corp., Albuquerque, N. Mex.). J. Mol. Spectroscopy, 6: 312-18(Mar. 1961).

Using the adiabatic theorem, a new perturbation method is developed for obtaining the energy levels of the slightly asymmetric top. Then, by expanding the energy levels in terms of Wang's asymmetry parameter $b = (C-B)/(2A-B-C)$, general formulas are obtained for the coefficients of b^n through $n = 7$ for all values of J and K. (auth)

14613 ON THE FUNDAMENTAL EQUATIONS OF INVARIANT IMBEDDING. [PART] I. Richard Bellman and Robert Kalaba (RAND Corp., Santa Monica, Calif.). Proc. Natl. Acad. Sci. U. S., 47: 336-8(Mar. 1961).

A rigorous exposure is given the connection between the transport equations for internal fluxes and the invariant imbedding equations for reflected fluxes for a one-dimensional transport process. Linearity of perturbation equations and the uniqueness of solution of a linear two-point boundary-value problem are the essential ingredients. It is shown how to derive quasilinear partial differential equations from equations such as the basic equations for a one-dimensional transport process involving N different types of particles. (T.R.H.)

14614 EQUIPMENT AND WORKING SYSTEM PLANNED FOR THE MATHEMATICAL SECTION OF THE HAHN-MEITNER INSTITUTE FOR NUCLEAR RESEARCH, BERLIN. W. Haack (Hahn-Meitner Inst. for Nuclear Research, Berlin). p.3-6 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A new laboratory for nuclear studies is being opened in Berlin. The section for applied mathematics, one of the four main sections of the laboratory, began operations three years ago with a Zuse Z-22 at the Technical University. More than one hundred programs, including methods for solving hyperbolic and elliptic differential equations, are contained in the library of the section. The programs are stored on magnetic tape units. A "closed

shop" policy is used whereby physicists, chemists and engineers bring their problems to a reception group for processing and calculation. A description of the offices and laboratories of the computing section, including the facilities for the new Siemens 2002 computer, is given. (auth)

14615 DIGITAL COMPUTER WORK AT KJELLER, NORWAY. A. Grammeltvedt (Inst. for Atomic Energy, Kjeller, Norway). p.7-10 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The work with digital computers at Kjeller, Norway, is reviewed. The Institute for Atomic Energy has access to a Ferranti Mercury computer. A description is given of the code library, which contains codes in the fields of reactor engineering, physics, shielding, reactor kinetics, burn-up, and others. (auth)

14616 CHARACTERISTICS OF THE ZUSE Z-22 AND ITS APPLICATION TO REACTOR CALCULATIONS. F. Stummel (Institut für Neutronenphysik und Reaktortechnik, Karlsruhe, Ger.). p.11-15 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

After a brief description of the technical characteristics of the Zuse Z-22, such as storage capacity, calculating speed, input and output, a summary is given of the experience gained with this machine at the Kernforschungszentrum Karlsruhe, Federal Republic of Germany, concerning calculations of cells of heterogeneous reactors by P_n- and S_n-methods, one-dimensional multigroup diffusion calculations of thermal and fast reactors, two-group diffusion calculations of two-dimensional cross-sections of heterogeneous reactors, Monte Carlo calculations, reactor dynamics, and optimalization of thermal and fast reactors. (auth)

14617 INSTALLING LARGE-SCALE COMPUTERS FOR NUCLEAR CALCULATIONS. M. E. Drummond (IBM United Kingdom Limited, London). p.17-22 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

This is a presentation of case histories of installing large-scale computers for nuclear calculations. One case will be that of an installation which started with very small equipment, another which went directly into a large computer, and another which took on nuclear calculations into an existing computing center. (auth)

14618 S_N CODE IN SPHERICAL GEOMETRY FOR IBM 650. S. Katsuragi, T. Nakayama, and R. Koinuma (Japan Atomic Energy Research Inst., Tokyo). p.127-51 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

An S_N code is presented in spherical geometry for IBM 650. The code is divided into two phases, one of which may be called S_N PROD, the other S_N POWER by analogy with the Knolls Atomic Power Laboratory's diffusion code. The former calculates angular flux and flux or current at each mesh-point, once source intensities are given. This phase requires several iterations in general. S_N POWER calculates source intensities, when fluxes are given. Arithmetic operations are performed by fixed-point. Both phases of the S_N code check on the type and sequence of input data. The input of S_N POWER is completely equivalent to diffusion POWER. That of S_N PROD is slightly different from diffusion PROD; 02 cards must always be included, 04 cards should not contain the constant creating source, 05 cards contain only transport cross-sections of 5 regions and do not contain region numbers. Finally, 1c and 09 cards must follow 06 cards, where 09 cards contain scattering cross-sections of 5 regions from i group to i itself. The output of two phases is almost equivalent to PROD and POWER of diffusion; the only difference in S_N PROD is the punching out of additional angular flux. However, this punching may well be omitted by the loading of punch control cards. The limitations of applicability were mainly restricted by the limit of drum location: number of groups ≤ 50, maximum number of fission spectrum of neutrons ≤ 20, number of mesh-points ≤ 50, number of regions ≤ 5, $N \leq 10$, maximum number of groups for inelastic transfer ≤ 7. The calculation requires about 3.5 sec per mesh-point; if control cards 9 are loaded, the inner iteration of S_N PROD is not necessary and we can save a little calculation time for each mesh-point. The tests were performed on two examples, the first of which was the calculation of non-escape probabilities. The second was the analysis of elementary fast assemblies based on six-group cross-section sets. (auth)

14619 SOME ASPECTS OF NUCLEAR REACTOR CALCULATIONS ON MEDIUM-SIZED ELECTRONIC COMPUTERS. A. Chiarini (Istituto Nazionale Fisica Nucleare, Bologna) and T. Pierantoni. p.179-84 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

Experience is given in the use of the basic IBM 650 electronic computer. In particular, the development of work in the calculations of criticality of many regions and totally reflected reactors, lattice parameters, burn-up and kinetics is described along with the experience acquired in the calculations of spatial distribution of neutron flux in subcritical and quasi-critical reactors and in compiling experimental data emphasizing the possibilities of fitting by several parameters. The main functions concern the problems of training the staff and organizing suitable codes which are subsequently introduced. Some suggestions are made on the Library codes and the exchange of programs among various centers, which within a few years should lead to the assembling of an international library of nuclear codes using a universal language. (auth)

14620 ZEUS—A GENERALIZED TWO-DIMENSIONAL FEW-GROUP DIFFUSION CODE FOR IBM 650. K. Arai (Central Research Lab., Hitachi Ltd., Tokyo), M. Higashi, K. Matsuoka, S. Terasawa, and T. Noda. p.185-218 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

ZEUS is a generalized two-dimensional few-group diffusion code, programed for the IBM 650. Though the use of the IBM 704 for this code is preferable, the situation for the use of large-scale digital computers in Japan has been unfavorable, making it necessary to use the IBM 650. The code is applicable for boiling-water reactor design analysis and provides information on the interaction between the power and moderator distributions through the boiling process. This code consists of two parts—HERMES and ZEUS. HERMES computes void-dependent 3-group constants, ZEUS computes neutron fluxes by solving diffusion equations under various boundary conditions, and computes void-volume fraction by using power-normalized fluxes. The numerical method employed in the inner iteration is

the Peaceman-Rachford method; that used in the outer iteration is the extrapolation method using Tschebyscheff polynominals. Geometrical parameters are as follows: r-z or x-y geometry; energy groups ≤3, space meshes ≤200, space regions ≤20, material regions ≤4, regions of void calculation ≤1; variable mesh spacing permitted. (auth)

14621 FLAME, A THREE-DIMENSIONAL BURN-UP CODE FOR LARC. E. H. Cuthill (David Taylor Model Basin, Washington, D. C.). p.219-36 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A general description is given of a flexible, large-scale, multigroup nuclear reactor code called FLAME. This code is being prepared for the LARC computing system to be installed by early 1961 at the David Taylor Model Basin, an activity of the U. S. Navy's Bureau of Ships. FLAME will be a three-space-dimensional burn-up code incorporating the solution of the neutron diffusion equations for up to four lethargy groups. Several options are included for calculating macroscopic cross-sections for the various materials present. The criticality calculations use the macroscopic cross-sections together with a geometric description of the reactor. In this description, for a two-group problem, for example, up to 125,000 network points can be used. A set of difference equations approximating the neutron-diffusion equations, together with interface and boundary conditions, will be solved for each group, using a normalized block-iteration method. An extrapolation procedure based on the use of Tchebycheff polynomials will be used to accelerate convergence in the calculation of the criticality factor and neutron source distribution. The input formats for FLAME have been designed so as to be compatible with those for TRANSAC codes being prepared at the Bettis Atomic Power Division and the Knolls Atomic Power Laboratory. The LARC will be the first computer with the speed and capacity to solve, with reasonable facility, the three-dimensional problems to be treated by FLAME. It is estimated the LARC will be three to four times as fast as TRANSAC for this type of code. (auth)

14622 APPLICATION OF HIGH-SPEED COMPUTERS TO REACTOR PROBLEMS. L. Blue, E. R. Cohen, and H. P. Flatt (Atomics International, Canoga Park, Calif.). p.243-9 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

High-speed computing machines are widely used at Atomics International for reactor research, design and engineering. Costs have been markedly reduced through the efficient use of both analog and digital computers. About 150 programs are used for reactor physics and engineering calculations. These programs are applied for solution of problems of neutron thermalization, neutron transport, reactor kinetics, reactor shielding, fuel burn-up, temperature distribution, experimental data reduction and processing, and cost analysis. The most often used of the above programs have been investigated with respect to improvement of mathematical, numerical, and programing techniques in an attempt to form a small set of efficient, easily used analytical tools. A sequence of S_n programs has been developed for both cell and reactor computations for plane, cylindrical and spherical geometry. In these codes it has been found that one of the best ways to decrease computer running time (by factors of 3 to 10) is to provide a reasonably accurate source and flux guess, for example by prefacing the S_n calculation with a diffusion theory calculation. A very fast, versatile program is used for diffusion theory calculations. This program finds the normal quantities such as multiplication factor, sources, and fluxes and will also find neutron balance checks, adjoint fluxes and associated importance integrals for perturbation theory calculations, material absorptions, and conversion ratios. A wide choice of boundary conditions is provided, and criticality searches for several parameters, and fuel burn-up calculations may be performed. Reactor kinetics calculations are performed using a program based upon an improved integration technique that permits large time intervals, thus yielding an economic program even for the simulation of reactor start-ups. For this type of calculation, computer running times have been reduced by a factor of as much as 100. The analysis of reactor transient power traces, many of which have milli-second periods is carried out completely by the computer. The power curves are automatically converted to punched cards by an analog to digital reader and the data are then smoothed and normalized from which the total energy, instantaneous reactor period and reactivity as a function of time are found. Selection of the cases to be run may be determined by the use of statistical experiment-design techniques and the optimization of the system is accomplished by use of linear programing methods. In all programs the attempt has been made to facilitate the use of the programs by simplifying the data input procedures and by providing complete and well-labeled computer output. (auth)

14623 CURE AND CUREM: NEW TWO-SPACE-DIMENSION MULTIGROUP NEUTRON DIFFUSION CODES FOR THE IBM 704/7090. Frank M. Trantham, Jr. (Computer Usage Co., New York). p.263-6 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A description is given of an existing and available IBM-704 Code, CURE, that solves the multigroup neutron diffusion equations for one to fifty lethargy groups in two space dimensions. Any of the three co-ordinate systems, X-Y, R-Z, or R-θ, may be used, with variable mesh-spacing (with or without point deletion), irregular outer boundaries, and various boundary conditions. A description is also given of a new, existing and available IBM-704 Code, CUREM, a version of CURE that has all of the features of CURE and in addition permits inelastic scattering from each of the first six high-energy groups into any or all groups of lower energy. Each of the codes uses the Sheldon-Wachspress generalization of the Peaceman-Rachford iteration technique (Alternating Direction Implicit Method) in the flux (inner) iterations in each group. Each of the codes uses an extrapolation scheme in the source (outer) iteration that utilizes three successive fission source distributions rather than the customary two. As many as 57 different material compositions and/or material regions may be specified. Output includes point-by-point topological edits of the power density distribution, the fission source distribution, and the flux distribution for each lethargy group. Other output includes the criticality eigenvalue, flux integrals by regions and/or material, the fraction of power generated in each region, a neutron economy balance in each group, and error residuals for both source and flux. The IBM-704 versions of the code are all existing, well-tested, running, and available. The IBM-7090 versions of the code can be made operable and available during 1960. Comparisons are given of the running times experienced on the IBM-704 and ex-

pected on the IBM-7090. The number of inner and outer iterations required to solve typical problems is discussed. It is shown that convergence can frequently be obtained using only one double-sweep of Peaceman-Rachford per group per outer iteration as compared with the many iterations per group required by Extrapolated Liebmann. Cost estimates are given and it is shown that the cost of solving two-dimensional multigroup problems will be reduced to a significantly new low level with the advent of the IBM-7090 versions of CURE and CUREM. (auth)

14624 THE INTEGRATION OF DIFFERENTIAL EQUATIONS BY CLENSHAW'S METHOD: MATRICIAL FORMULATION AND NEW POSSIBILITIES. B. Lago (Commissariat a l'Energie Atomique, Saclay, France). p.287-304 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

Clenshaw's method may be used to solve differential equations in cases where the equation is linear in relation to the function and its derivatives and the coefficients are polynomials of the variable, and it is desired to characterize the function by its expansion in Tchebycheff polynomials. Relations are established between the expansion coefficients of the function and its derivatives. These relations are then arranged in matrix form. This makes possible a very simple formulation of Clenshaw's recurrence method. The behavior of the recurring series of vectors which appear in the preceding method is then examined; in particular, a demonstration is given of the characteristic values dependent on rank r. The variation of these characteristic values with r provides information as to the possible convergence of the expansion and, in particular, enables one to deduce, with a verified accuracy, whether or not Clenshaw's method will be successful. This interpretation of Clenshaw's method leads quite naturally to a modification of the formalism in order to avoid the failures in convergence. Two new formalisms are given: one is an adaptation of the traditional method for refining the eigenvectors with relation to eigenvalues of raised modulus, by orthogonalization in the course of calculating the eigenvectors of a matrix. These formalisms have yielded good results in the cases so far studied. Some indications are given of the possibilities of the method, especially with regard to non-homogeneous equations and the calculation of the asymptotic expansion of the solution of a differential equation. (auth)

14625 NEUTRON DIFFUSION THEORY PROGRAMMES AND THEIR APPLICATION TO SIMPLE CRITICAL SYSTEMS. S. Stone and R. Lingenfelter (Univ. of California, Livermore). p.307-29 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The University of California Lawrence Radiation Laboratory has developed a series of reactor neutronic programs for an IBM-709 Data Processing System. These include both one- and two-dimensional multi-energy-group, neutron diffusion theory criticality programs and a series of codes used to prepare nuclear input data. The diffusion equation solved by the criticality codes, for any energy group i, and in the k^{th} zone, may be written: $D_k^i \nabla^2 \varphi^i(\vec{r}) - \left({}_f\Sigma_k^i + {}_c\Sigma_k^i + \sum_{j \neq i} {}_s\Sigma_k^{i,j} \right) \varphi^i(\vec{r}) + \sum_{j \neq i} {}_s\Sigma_k^{j,i} \varphi^j(\vec{r}) + \frac{F^i}{\lambda} \sum_j {}_f\Sigma_k^j \varphi^j(\vec{r}) = 0$. where φ is the scalar flux, D is the diffusion coefficient, Σ is the macroscopic cross-section with ${}_s\Sigma^{i,j}$ the scattering cross-section from the j^{th} to the i^{th} group, and F^i is the number of neutrons per fission born in the i^{th} group. The one-dimensional program is memory-contained with the capacity to handle up to 18 energy groups, 15 materials, and 40 spatial regions. It has among its features: high-order differencing of the differential equation, transfer of neutrons between all energy groups, a power extrapolation technique, an energy-dependent extrapolation length boundary condition at the outer boundary. The two-dimensional program handles up to 18 energy groups, 20 to 40 materials, 300 to 500 regions, and up to 2000 spatial points. The scattering (${}_s\Sigma^{i,j}$) is limited to $i = j + 1$; $i = j - 1$; $1 = j - 2$. An alternating direction sweep scheme is used in the solution, and an energy-dependent extrapolation length boundary condition may be applied to interior as well as to exterior boundaries. The constants used in these codes are obtained from a series of programs which find flux-weighted averages of experimental data. These are modified to account for disadvantage factors, anisotropic scattering, and for the (n, 2n) reaction of Be^9. A series of enriched-uranium beryllium-oxide moderated critical measurements was performed at LRL for the specific purpose of evaluating these computer programs. These included bare and graphite-reflected assemblies, using atomic BeO/U^{235} ratios from 247/1 to 7660/1, arranged in simple one- and two-dimensional rectangular parallelepiped arrays. The computer programs yield results in generally good agreement with the experimental data. (auth)

14626 SURVEY OF REACTOR CODES AVAILABLE FOR IBM COMPUTERS. H. Knopp (IBM, Sindelfingen, Ger.). p.331-4 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A survey is given of the reactor codes for IBM computers which are of general interest and generally available for use. The codes mentioned in the survey are grouped according to the mathematical methods used and within these groups according to the computer types for which the programs were developed. The survey considers the latest publications. Finally, it mentions the computations processed at IBM Germany and the experiences encountered. (auth)

14627 NUCLEAR REACTOR CODES IN THE UNITED STATES. W. Sangren (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.335-40 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

By January 1960, over 400 nuclear reactor codes had been written in the United States. Some 50 scientific installations have participated in writing codes for all aspects of reactor design. The codes are difficult to classify, but for convenience can be considered to fall into the following classes: burn-up, engineering, group diffusion, kinetics, miscellaneous, Monte Carlo, physics and transport. Although codes have been prepared for over 20 types of digital computers, the majority of reactor codes between 1956 and 1960 were written for the IBM 704. It is unlikely that this dominance by one type of machine will continue beyond mid-1960. The need for writing codes in a common program-oriented language such as FORTRAN or ALGOL is therefore of increasing importance. The interchange of reactor codes has involved many difficulties. There has existed no standard method of exchange of nuclear codes. Most exchanges have taken place on an individual-to-individual or at best an installation-to-installation basis. The Nuclear Codes Group (NCG), now the Reactor Mathematics and Computations Division of the American Nuclear Society (ANS), has met simultaneously with the ANS for the last four years. In the NCG meetings,

the dissemination of general and specific code information as well as experience in running the codes has been presented. A good deal has been learned in the last three years about the economics of running nuclear codes on digital computers. It is now possible to estimate reasonably accurately the cost of carrying out for a given reactor configuration many of the standard reactor calculations, such as kinetics, burn-out and one- and two-dimensional group criticality calculations. (auth)

14628 THE DEVELOPMENT OF NUCLEAR CODES IN JAPAN. T. Yamada (Japan Nuclear Codes Group, Tokyo) and T. Aoki. p.341-84 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The development of the peaceful uses of atomic energy in Japan began in 1954. Since then, nuclear engineers have made much progress by studying the foreign technology. However, they faced considerable difficulties in solving their own problems because of the lack of automatic computers. In 1955, the domestic computer made its first appearance. Then a few research laboratories installed their own computers and the small machine computing center was opened. In 1958, Japan entered into her second stage with the importation of several foreign computers and the production of domestic medium-scale computers. These machines were immediately put into use for nuclear calculations, extending the scope of the research work in this field. During 1959, Japanese engineers devoted much effort to the development of nuclear codes. Under these circumstances, the Japan Nuclear Codes Group (JNCG) was organized in September 1959, for the purpose of exchanging information, compiling a code library, discussing new topics, and so on. This group plays an important role in this field in Japan. The Shielding Codes Group (SCG) was established later in the same year, with the intention of developing codes for reactor shielding and safety considerations. At present, about 20 organizations participate in JNCG, and more than 50 codes have been registered, a list of which is reported. Thirteen out of 30 large- and medium-scale computers installed in Japan are being used for reactor calculations. In addition, five scientific relay computers, which have contributed a great deal in the dawn age, are still being used. A fact worth remarking is that, because of the extremely limited availability of large computers, much effort has been made to use medium-size computers for large-scale problems. (auth)

14629 A TWO-GROUP CALCULATION FOR A FINITE ASYMMETRICAL REACTOR. A. de Matteis, P. Giacobbe, and C. Tamagnini (Centro Nucleare, Ispra, Italy). p.385-92 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A program scheme is given for two-group criticality calculations of multi-reflected cylindrical or parallelepiped reactors, and the numerical indeterminations encountered during the calculations are treated. Spinrad's method, which treats a wholly reflected cylinder alternatively as a radially bare equivalent cylinder and as an axially bare equivalent cylinder was followed. The calculations are carried out until they become consistent. Spinrad's calculation sheets were extended to take into account the possibility of asymmetry in the axial reflectors, anisotropy in the diffusion of neutrons, eigenvalue ≤ 0, and an annular core surrounding either a moderator or any material in which a flat flux has been assumed. The adjoint problem was also solved. The sheets, thus generalized, were coded for the IBM 650, using floating-point arithmetic. The input data are the macroscopic constants and the output obtained are the K_{eff} of the reactor and the fluxes and adjoint fluxes for the corresponding eigenvalue. The time required for the determination of the K_{eff} of a wholly reflected cylindrical reactor is about 1 hour; the time for flux tabulation depends, of course, on the number of points required. A point requires about 50 seconds in the radial direction and 6 seconds in the axial direction. The program has been used for parametric studies on different types of reactors. During these calculations, in some cases, numerical criticalities both in the eigenvalue search and in the flux tabulation were encountered. To overcome these indeterminations it was necessary to change the form of the calculation sheets or to use devices that are described. (auth)

14630 STATUS OF THE WORK ON THE INTERNATIONAL ALGORITHMIC LANGUAGE ALGOL. P. Naur (Regnecentralen, Copenhagen). p.415-26 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960." (In English, French, Russian, and Spanish)

References are given to descriptions of the ALGOL language in the literature, and a list is given of translators for it. The publication of algorithms is reported, and the usefulness of ALGOL for reactor codes is discussed. (T.R.H.)

14631 NUMERICAL SOLUTION OF QUASI-LINEAR EQUATIONS. E. R. Cohen and H. P. Flatt (Atomics International, Canoga Park, Calif.). p.461-84 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The problem of obtaining a numerical solution of the quasi-linear equation $dy/dx = \alpha y + F(x,y)$ is central in the development of digital computer codes for certain reactor computations. Equations of this type occur in a wide range of reactor problems: in reactor kinetics, in the description of the secular changes in a reactor (reactor burn-up), in the specification of control systems, and in nuclide decay chains. Equations of this type appear also in many other branches of engineering and applied mathematics. The approximate method of numerical integration developed by Cohen represented a first attempt to circumvent the difficulties inherent in the Runge-Kutta method or in any method which is based on a Taylor series expansion of the solution. Cohen's method has proved useful in increasing the speed of numerical integration but his formulation was not optimized with regard to the number of numerical operations nor has it been possible so far to obtain an estimate of the truncation error in any manner other than an experimental one. If the equation is recast into the integral form $y(h) = y(0)\, e^{\alpha h} + \int_0^h F[x', y(x')]\, e^{\alpha(h-x')}dx'$, this may be used instead as the starting point for a numerical solution. Two alternate methods of solution are discussed. One method is a direct generalization of the Runge-Kutta concept. It has the disadvantage that it becomes unwieldy beyond the third order and cannot be extended with full accuracy to systems of differential equations. The second method may be more easily generalized to form higher order correct formulas. Systems of quasi-linear equations may also be treated. Both methods lead to a second-order formula of the type $y(h) \approx y(0)\, e^{\alpha h} + h[\gamma_0(\alpha h)\, F_0 + \gamma_1(\alpha h)\, F_1]$, where in both methods $F_0 = F[0, y(0)]$, $F_1 = F\{u(\alpha h)\, h, g[\alpha h, y(0), F_0]\}$. In these formulas, the most significant difference between the two methods is that in the first u is a function of αh and in the second u is independent of αh. Applications of these formulas in various areas are discussed. Of particular interest is the application to the solution of reactor burn-up equations. (auth)

14632 A NEW ACCELERATION METHOD FOR TWO-DIMENSIONAL DIFFUSION APPROXIMATION. T. Nakayama (Japan Atomic Energy Research Inst., Tokyo). p.485-505 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The conventional methods for flux iterations employed in two-dimensional diffusion codes are: the extrapolated Liebmann method, the residual polynomial generation method, and the alternating direction implicit method. Of the above three, the first is the most easily programed and its convergence rate is comparatively fast. The third is the fastest method, but it is difficult to program and is not much faster than the first method. Theoretically the second is faster than the first, but the second is not very effective in actual calculation. These methods are based on the concept of changing the matrix A of $\varphi = A\varphi + S$ (φ: flux vector to be obtained) so that its maximum eigenvalue is minimized. The method presented here differs from the above in that the approximate values of the desired solutions are estimated from the behavior of the decrease of the error vector. This method is expected to speed up the convergence rate to a great extent. The two theorems about the non-negative matrix are the basis for this procedure. From these theorems it can be said that the relation between the desired flux vector φ and the successive approximation vector $\varphi^{(t)}$ is expressed at every mesh-point by the formula $\varphi_i^{(t)} = \varphi_i + C_i\lambda^t + \Delta_i$ where λ is the maximum eigenvalue and t is the number of iterations, $1 > \lambda > 0$. In the above equation Δ_i can be neglected for sufficiently large t. Hence the next approximate value is calculated by $\varphi^{(t+1)} = (1/1-\lambda)\,\varphi^{(t+\frac{1}{2})} - (\lambda/1-\lambda)\,\varphi^{(t)}$, where $\varphi^{(t+\frac{1}{2})} = A\varphi^{(t)} + S$. This is a simple formula like the one used in the Liebmann method and is easily programed. Actually the behavior of the error vector decreases at the rate of $C\lambda^t$ at an inner point while the result of testing on a digital computer (IBM 650) showed that it converges to zero even faster at a point in the neighborhood of the boundary. It should be noted that the value of λ is different at each mesh-point. (auth)

14633 INTERPRETIVE DIFFERENTIAL EQUATION ANALYSER (IDEA) ON USSC. H. Genchi (Tokyo Shibaura Electric Co.) and K. Aoki. p.513-31 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A most important task is the solving of ordinary differential equations, especially reactor kinetic equations. Numerical solutions of these equations are feasible on a digital or an analog computer. Of the two, the analog computer is the simpler to program, but unfortunately its accuracy is limited to two or three significant digits. Although the digital computer calculates accurately, the programing for it is rather complex. To combine the merits of the two methods, an interpretive routine was devised for pseudo-codes, which are as simple as, and very similar to, the block diagram of an analog computer. Using this routine, reactor kinetic equations, inelastic scattering cross-sections of U^{238}, and burn-up problems, were solved. The results of the calculations are in good agreement with the analytic solutions or with the results of experiments. The main features of this routine are: performance of numerical integration by the Runge-Kutta method, performance of all calculations by the interpretive method and by fixed-point arithmetic, step interval "h" is variable during the calculation, ability to solve very high order (up to 100th order) single or simultaneous differential equations, and possession of 250 arithmetic components including integrators (J,100), adders (A,50), dividers (D,10), constants (K,50), function generators (F,10), relays (R,25), time delays (L,4), outputs (O,5), and independent variable (T,1). The characters in the brackets represent the symbolic letters of the components; the numbers represent the numbers of each component. Multiplication is performed by adders or integrators. Each pseudo-code is composed of ten alpha-numeric characters, divided into four parts [part (a)/XXX] [part (b)/XXX] [part (c)/XXX] [part (r)/X] where part (a) designates the operating component, parts (b) and (c) designate the input components. (There are some exceptions.) Part (r) is used when the relays are employed. For example, the procedure is used in solving the equation,

$$\frac{d^2y}{dx^2} = -xy \quad \begin{matrix} \text{for } 0 \le x \le 1 \\ h = 0.01 \end{matrix}$$

initial conditions $dy/dx = -0, y = 2$, at $x = 0$ to print out every 5 steps. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

14634 (AD-245858) THERMOELECTRIC MATERIALS FOR POWER CONVERSION. Quarterly Progress Report No. 6, May 1, 1960 - July 31, 1960. B. Abeles, K. L. Cheng, G. D. Cody, B. E. Baughan, E. F. Hockings, N. E. Lindenblad, and G. M. Muha (David Sarnoff Research Center, Princeton, N. J.). Aug. 15, 1960. Contract NOBS-77057. 25p.

Materials research on ternary compounds and transition metal silicides together with high temperature thermal diffusivity measurements on $AgSbTe_2$, Ge and Si are described. Specimens of stoichiometric $AgSbTe_2$ were found to contain about 2% of a separate phase which is probably Ag_2Te. The materials represented by $(Cu, Ag, Au)_2Te$ were examined and a single-phase solid Ag_3CuTe_2 was prepared. It was found to be an n-type semiconductor. The transition metal silicides were examined further and it was concluded that there is only a very small possibility of obtaining useful materials for high temperature thermoelectric applications from this class of compounds. Measurements of thermal diffusivity on Ge and Si were made at temperatures up to 800°C with an experimental accuracy of 2%. An analytical method for the estimation of bismuth in thermoelectric materials is described. (auth)

14635 (ANL-6294) DIFFUSION-CONTROLLED DISSOLUTION OF ZIRCONIUM IN MOLTEN URANIUM WITH MONOTONICALLY INCREASING TEMPERATURE. Gerald H. Golden (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 43p.

The diffusion-controlled dissolution of zirconium in molten uranium was studied for the case in which the temperature increased monotonically with time. A physical model for diffusion-controlled dissolution was postulated, and the equations solved for the specific cases in which the temperature increased linearly, exponentially, and parabolically with time. In order to solve these equations it was found useful to transform time as an independent variable to a parameter τ which takes into account the variation with time of the temperature and diffusion coefficient. For the range of parameters considered to be of experimental interest, the recession of the solid-liquid interface as a function of τ was approximately given by the same expression for all three cases of temperature variation: $\Delta L = 2(\tau/\pi)^{1/2} [b + (2/3) a\tau]$. Here ΔL is the interface recession, and a and b are constants determined from the conditions of the specific case being studied. The dissolution equations developed in this study may well be applied to the investigation of the diffusion-controlled dissolution of certain of certain other metals in molten uranium. (auth)

14636 (CEND-112) THE DEVELOPMENT AND TESTING OF THE UO_2 FUEL ELEMENT SYSTEM. Quarterly Report [for] September 1, 1960—November 30, 1960. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Dec. 1960. Contract AT(30-1)-2379. 63p. (NYO-9010)

Work was continued on the vibratory compaction of UO_2 and densities as high as 94.1% of theoretical were attained. Several rods, containing vibratory compacted UO_2, compacted to above 90% of theoretical density, were subjected to small cross-sectional reductions via swaging in an attempt to increase the fuel density. Methods of testing UO_2 fuel rods were investigated. A cost estimate was performed with the object of determining the difference in fuel cycle costs between pelletized, vibratory compacted, swaged, and Rock-Rited fuel rods. (W.L.H.)

14637 (HW-67120) ANALYSIS OF QUALITY CERTIFICATION DATA—EFFECT OF WARP ON THE INCIDENTS [sic!] OF HOT SPOTS. L. T. Hagie and J. L. Jaech (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 14, 1960. 6p.

Data from some 2000 fuel elements irradiated under the Quality Certification Program were summarized for statistical analysis by the IBM-709. Results are presented of a single analysis of the relationship between warp and hot spots on normal production fuel elements. (W.L.H.)

14638 (LAR-49) MODIFIED-GRAPHITE TECHNOLOGY. Final Report. C. W. Boquist and S. W. Bradstreet (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 5, 1961. Changed from OFFICIAL USE ONLY Mar. 15, 1961. Contract AT(33-3)-4. 59p.

Slightly more than three years of experimental research in fine-grained, molded multicrystalline graphite are reviewed. The work in binder development involved preliminary screening of several hundred candidate materials; coal tar pitch and pre-polymerized furfuryl alcohol were finally selected. A technique was finally developed for rapid carbonization of mixes containing pre-polymerized furfuryl alcohol. Additions of natural uranium to the experimental mixes were evaluated. Additions were made in the form of UO_2, U_3O_8, U, UC, UC_2, and UC_2 coated with pyrolytic carbon; only the last did not result in significant weakening. The need for reproducible physical properties in structural graphite was responsible in this work for the development of refined methods for measuring flexural and tensile strength and modulus to temperatures above the creep threshold of ordinary graphites (about 2500°C). The nondestructive measurements (expansion, density, electrical resistance, and dynamic moduli) were found to provide, for graphites of the same kind, a basis for prediction of strength at high temperatures. A program aimed toward achieving optimum physical properties in graphites of this kind is recommended. (auth)

14639 (NMI-1232) ISOTOPIC INTERCHANGE IN DISPERSION FUELS. D. S. Kneppel (Nuclear Metals, Inc., Concord, Mass.). Oct. 20, 1960. 47p. Contract No. AT (30-1)-1565.

An investigation was made of the extent of isotopic interchange that would occur in a dispersion-type fuel element consisting of fully enriched UO_2 particles dispersed in a uranium matrix. The limiting factor in the interchange is the diffusion rate of uranium in UO_2. Experimental results gave approximate values of the volume diffusion of 4 to 45 45×10^{-18} cm^2/sec at 1000°C. Radiation damage in the matrix as a result of isotopic interchange was judged to be very unlikely. (auth)

14640 (NMI-2093) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for January 1961. (Nuclear Metals,

Inc., Concord, Mass.). Mar. 20, 1961. Contract AT (30-1)-1565. 27p.

Plans were formulated for the fabrication of enriched uranium oxide fuel elements by hot extrusion. The development of fuel sub-assemblies from large composite sheets with dimples in non-fueled areas, from which large spiral and ribbon-candy models can be made is described. Al-clad Al-25 wt.% U plates were used for preparation of the core. Techniques of swaging and drawing for fabrication of yttrium metal without a protective cladding were developed. Three organic solvents were studied to determine their efficiency in the decontamination of U^{232}-bearing fuel. The extractants were Aliquot 336, Alamine 336, and TBP. Alamine 336 gave the best results. The extraction isotherm indicated that if three extraction stages were used at a solvent-to-aqueous ratio of about 1.1 to 1, 99.99% uranium extraction could be effected. Ammonium chloride was used as the stripping solution and 99% of the uranium was stripped in two stages. Successful extrusions of aluminum were carried out at room temperature utilizing a high-pressure fluid in the lines. Extrusion reductions from 5× to 47× were achieved. An investigation was made of the mechanism of corrosion of zirconium alloys in high-temperature steam, with emphasis on the role of intermetallic precipitates. The thermodynamics of the interaction of gases with zirconium intermetallic compounds, the structure and properties of the metal substrate beneath the oxide film on corroding zirconium, and oxide film growth were studied. Thermal analysis, beta-phase boundary studies, and investigations of the possibility of retention of the beta phase were carried out on Be–Ba alloys. (M.C.G.)

14641 (NMI-9509) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period October 1, 1960–December 31, 1960. S. H. Gelles (Nuclear Metals, Inc., Concord, Mass.). Mar. 1, 1961. Contract AF33(616)-7065. 114p.

Work done on the development and research of beryllium is discussed. The areas include: purification by iodide decomposition, ultrasonic welding, distribution of oxides and voids, dislocation effects, surface damage, brazing, forge welding, resistance spot welding, distillation, product evaluation, aging and strain aging, and increasing the yield strength. (B.O.G.)

14642 (ORO-325) MATERIALS FOR HIGH TEMPERATURE NUCLEAR ENGINEERING APPLICATIONS. Progress Report No. 2, August 15, 1959 to August 15, 1960 (Part 1). J. D. Fleming and J. W. Johnson (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2483. 91p.

Investigations of the properties of slip cast fused silica were continued. The slip had a particle size distribution of 94% less than 44 microns and 13% less than 1 micron. A statistical study was carried out to evaluate the relative importance of the different slip casting variables. Surface contamination of the silica was minimized by removal of the Keltex prior to firing or by using the graphite mold release. Vibration of the silica slip during casting was found to increase the reproducibility of fired strength by a factor of about two but to result in a substantial decrease in the level of strength. Methods of heat treating the silica were explored in an attempt to increase the strength of fired silica bodies but none proved successful. Tensile strengths of the silica determined at elevated temperatures varied from ~ 3,000 psi at room temperature to ~ 8,000 psi at 2000°F. Mathematical analysis of the tracer gas permeation measurement system was completed. Studies were begun to decrease the permeability of the porous silica by various sealing techniques. Design studies were begun for the construction of an electron microscope hot stage for the investigation of the bonding method of slip cast fused silica, and the mechanics of devitrification of fused silica. Development of a temperature monitor for the hot stage was begun. Devitrification studies were continued using a high temperature x ray diffractometer. Difficulties with platinum evaporation from the heating elements prompted development of a new furnace. Preferred orientation of the devitrification products in fused silica was investigated. Fused silica was irradiated to a total fast dose of 1.5×10^{20} nvt; the cristobalite in the fired samples was reconverted almost completely to amorphous silica under the irradiation. An experiment was designed to allow irradiation of fused silica at high temperatures produced by gamma heating. A comparative study of the slip casting behavior of several different refractory materials was begun. An alumina slip was developed which yielded bars with a fired modulus of rupture in excess of 20,000 psi. A system was constructed for motion photomicrography of slip casting. Investigations were begun of the formation of refractory fuel mixtures by self-sintering exothermic reactions. (auth)

14643 (ORO-335) FUEL CYCLE DEVELOPMENT PROGRAM MONTHLY NEWSLETTER. R. L. Robinson (National Carbon Company, Fostoria, Ohio). September 1960. 7p. Contract AT(40-1)-2560.

Work was continued on UO_2 agglomeration in TS-160 mix. Impregnated rods with 15 wt.% UO_2 were examined by x-ray diffraction for trace impurities. Small to large amounts of UO_2 were found in rods which had been twice graphitized to 2400°C. The use of gamma emission for nondestructive determinations of U content and uniformity in fuel elements is being investigated. A microhardness method is being investigated for use in determining UC or UC_2 in carbide samples. The migration of U from fuel compacts during high-temperature processing is being investigated. The preparation of a fueled-graphite element for irradiation testing is reported. (W.L.H.)

14644 (SCNC-313) QUARTERLY TECHNICAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1960. J. L. Zambrow (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). September 1960. Contract AT-30-1-GEN-366. 9p.

Work was completed on the fabrication of low cost ceramic fuel elements by isostatic pressing. Work was also completed on the fabrication of uranium dioxide fuel elements. The irradiation behavior of stainless steel-clad, isostatically pressed UO_2 samples is being determined. Investigations were continued on the determination of the characteristics and dimensional stability of two U–Y alloys under neutron irradiation at high temperatures. (W.L.H.)

14645 (TID-11065) INFORMAL LETTER PROGRESS REPORT. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). October 1960. 7p.

The preparation of isostatically pressed UO_2 for irradiation is reported. Additional runs were made in the low-temperature furnace to convert UF_6 directly to UC. Results of high-temperature reactions of UF_4 with Si are reported. (W.L.H.)

14646 (TID-11295(Suppl.)) NUCLEAR FUELS AND MATERIALS DEVELOPMENT (SUPPLEMENT). (Division of Reactor Development, AEC). Feb. 1961. 52p.

Fuels. Long thin plates of U–3.8 Mo–0.2 Al were cast. The densities and viscosities of liquid Pu and Pu–Fe eutectic mixture were measured up to 925°C. Phase equi-

librium diagrams of the Pu–Cu and Pu–Ce–Cu systems were determined. Uranium silicide was investigated for use as a high-temperature, long-burnup fuel. Preparation, fabrication, mechanical properties, and compatibility with Nb alloys is discussed for uranium carbide. Properties of PuC and PuC–UC mixtures were studied. Irradiation Testing. Measurable diffusion occurred through the Al_2O_3 coatings of irradiated UO_2 pellets. The irradiation behavior of PuC, UC–20 wt.% PuC, Pu–1 wt.% Al, Th–Pu, U–Pu–Fissium, and Zr–Pu alloys was investigated. Irradiations of U–5 wt.% fissium alloy indicated that the alloy will be able to withstand the desired EBR-II core conditions. Th–U alloys were irradiated to determine their suitability for high-temperature fuel elements. Fabrication. BeO–30% UO_2 dispersions were fabricated by cold pressing and sintering to 95% theoretical density for irradiation tests. Differential thermal analysis and thermogravimetric studies were made of the calcination of $BeC_2O_4 \cdot 3H_2O$. Cladding and Container Materials. Nb was studied for use both as cladding and as a bond and diffusion barrier material between a U alloy fuel and Al cladding for organic cooled reactors. Phase equilibria of the Nb–Zr system were determined. Long-term corrosion tests were performed on a low-Si, Al alloy A288 containing 1 wt.% Ni, 0.5 wt.% Fe, 0.1 wt.%, Ti, and 0.001 wt.% Si max. The development of Zr alloys for cladding and jackets for use in superheated steam continued. The corrosion behavior of Fe in water containing O_2 was investigated. Liquid-Metal Compatibility Studies. Batches of commercial K were purified by hot gettering and subsequent cold trapping to produce a relatively pure material for use in compatibility and heat transfer experiments. Nine refluxing K compatibility tests were conducted to provide screening information regarding the comparative corrosion resistance of Fe, Ni, Co, and Nb alloys. Results of boiling K loop tests are discussed. Nondestructive Testing Development. Studies of ultrasonic behavior in thin sections were directed toward the detection and evaluation of nonbond areas in clad structures. Development of a suitable technique and calibration of gamma spectrometry equipment for U–Al core blanks were essentially completed. The dual-frequency, probe-type eddy current inspection technique was employed in the inspection of Zircaloy-2 tubing. Neutron radiography techniques are discussed. (M.C.G.)

14647 (TID-11756) SPATIAL DISTRIBUTION OF DISCRETE PARTICLES. Technical Report No. 3. J. Gurland (Brown Univ., Providence). Feb. 1961. Contract AT(30-1)-2394. 18p.

For presentation at Symposium on Quantitative Metallography, Univ. of Florida, February 1-3, 1961.

Definition and measurement to topological variables related to the distribution of particles of one phase in multiphase aggregates are discussed. Measurements were made of the contact area and the number of contacts between particles of one phase. The degree of dispersion is defined. The characteristic particle spacings expected in very dilute dispersions of random distribution were calculated. An attempt was made to relate the frequency of particle contacts to the degree of continuity of the embedded phase. The degree of dispersion was found to be proportional to the extent of the surface of separation between the particulate phase and the matrix. An idealized aggregate of random contacts containing no redundant connections or closed paths was assumed. The critical average number of contacts per particle in the chain was calculated to be 2. (M.C.G.)

14648 (TID-11826) NICKEL–CHROMIUM–IRON ALLOY PIPE AND TUBE; CORROSION RESISTING, FOR RADIOACTIVE SYSTEM SERVICE. C. F. Barrett, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 17, 1958. Contract W-31-109-eng-52. 14p. (KAPL-Spec.-KPM3-48).

Materials specifications are outlined for annealed, seamless, and welded chromium–iron–nickel alloy pipe and tubing designated for service in radioactive systems. (B.O.G.)

14649 (TID-12145) TRANSPORT PROPERTIES IN LIQUID METALS. Progress Report, May 1, 1960 to February 23, 1961. (Michigan. Univ., Ann Arbor). Feb. 1961. Contract AT(11-1)-771. 4p.

A description is given of experimental work undertaken to investigate the structure and properties of liquid metals by diffusional processes. Electric mobility studies using bismuth and mercury are described. A mathematical analysis was made of the electro-diffusion process. Techniques were investigated for measuring resistivities and thermal diffusion coefficients using Bi-Sn and Bi-Ni, respectively. (B.O.G.)

14650 (TID-12174) LIQUID SOLID INTERFACIAL TENSIONS IN METAL ALLOY SYSTEMS. Status Report and Renewal Proposal [of] Contract AT(30-1)-1994. C. W. Spencer (Cornell Univ., Ithaca, N. Y. School of Chemical and Metallurgical Engineering). Feb. 15, 1961. 17p.

A study of the plastic strain introduced in polycrystalline nickel prior to exposure to liquid bismuth found that the rate of liquid-phase penetration into grain boundaries was significantly increased. The depth of penetration at 670, 850, and 915°C is given as a function of compressive strain. Preliminary investigations were conducted on liquid-phase penetration in the Al-Ga alloy, by exposing aluminum specimens to liquid gallium at 70 ± 1°C until the grain surfaces were penetrated. The penetration rates tend to diminish from 4×10^{-5} cm/sec to 2×10^{-6} cm/sec. The effects of intergranular films of liquid bismuth on grain growth in nickel was investigated at 670°C. A study of techniques for the production of oriented single and bi-crystals of nickel resulted in a method for growing suitable single crystals. Bi-crystals produced thus far resulted in grain boundaries tending to wander off the edge of the specimen or to twist inside the specimen. A study of the monotectic transformation in the bismuth-selenium alloy indicates that the mechanism and the structures resulting from the transformation are influenced by the liquid-solid interfacial tensions during the transformation. (B.O.G.)

14651 (AEC-tr-4056(p.12-26)) PRODUCTION OF AMORPHOUS BORON OF HIGH PURITY. I. REDUCTION OF BORON ANHYDRIDE BY LIGHT METALS. V. I. Mikheeva, F. I. Shamrai, and E. Ya. Krylova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1223-31(1957).

The production of amorphous boron by reduction of boric anhydride with Li, Na, K, Ca, Mg, Be, and Al was investigated using the methods of thermography and chemical analysis of the solid products of the reactions as obtained through acid treatment. Results indicated the increasing ability of metallic reducing agents to form borides of constant composition in the ascending order K, Na, Li, Be, Mg, Ca, and Al. In order to produce amorphous boron on a commercial scale, the magnesiothermic reaction for the reduction of boric anhydride, which results in a product containing 77 to 80% boron after the first acid treatment, is recommended. (M.C.G.)

14652 (AEC-tr-4056(p.27-41)) PRODUCTION OF AMORPHOUS BORON OF HIGH PURITY. II. PHYSICO-CHEMICAL ANALYSIS OF THE REACTION OF MAGNESIUM WITH BORIC ANHYDRIDE. V. I. Mikheeva, V. Yu. Markina, and O. N. Kryukova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1232-41(1957).

The reaction of boric anhydride with magnesium was studied. The concentrations of the components of the reaction mixture ranged from 0 to 100%, and the methods of differential thermal analysis and full chemical analysis of the reaction products were used. Composition vs. property curves were constructed in which the properties were indicators of the efficiency of the reaction, the yield of the reaction, and the quality of amorphous boron. The addition of sulfur to the reaction mixture lowered the temperature considerably at the beginning and made the reaction more vigorous. It also had a favorable influence on the yield of dry residue and on the yield of total and active boron. The best results for yield and percentage boron were given by a charge composition corresponding to 55.10 wt.% boron anhydride and 44.90 wt.% magnesium. (M.C.G.)

14653 (AEC-tr-4056(p.42-52)) PRODUCTION OF AMORPHOUS BORON OF HIGH PURITY. III. REFINEMENT OF AMORPHOUS BORON. F. I. Shamrai, V. I. Mikheeva, and E. Ya. Krylova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1242-7(1957).

Examination of existing data on the nature of the contaminations in amorphous boron and on the methods of its refinement showed the advantage of the principle of vacuum refining at elevated temperatures. Since in this method a considerable part of the charge preparation must be converted to the gaseous state and again condensed, certain recommendations for the enrichment of amorphous boron which do not require complex apparatus were experimentally confirmed. Experiments carried out for the enrichment of amorphous boron included elutriation of crude boron, enrichment by means of molten boric anhydride, treatment with chlorine, annealing in vacuum at 1000 to 1100°C, and vacuum refining. It was found that vacuum refining increased the boron content of the powder from 77 to 98% by a single operation, without any acid treatment at all. The optimum conditions were continuous heating for 2 hr. at 1500 to 1600°C followed by 3 hr at 1600 to 1800°C. (M.C.G.)

14654 CONTRIBUTION TO THE STUDY OF THE PRECIPITATION OF RARE GASES IN METALS. Viviane Lévy, Alexis Kirianenko, Gilbert Brebec, and Yves Adda. Compt. rend., 252: 876-8(Feb. 6, 1961). (In French)

A Castaing microanalyzer with electronic probe was used to measure the local rare gas concentration in metallic samples where the gases were introduced by electric discharge. When the samples are thermally treated, micrography reveals the formation of gas blisters in the regions where the gas concentration is sufficiently large. (tr-auth)

14655 AN INVESTIGATION OF THE DEPENDENCE OF ELECTROPHORESIS ON TEMPERATURE IN ALLOYS BASED ON HIGH MELTING POINT METALS. M. D. Smolin and I. N. Frantsevich (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Doklady Akad. Nauk S.S.S.R., 136: 81-3(Jan. 1, 1961). (In Russian)

Experiments with Mo–25 at.% W and W–25 at.% Mo at 1500 to 2200, 1700 to 2200, 1900 to 2400, and 2100 to 2500°C indicated the migration of Mo ions, under the action of an electric field, in the direction of the anode and W ions in the direction of the cathode. The electron concentration n_- calculated on the basis of charge and atomic concentrations of both components are tabulated. (R.V.J.)

14656 PICKLING EXPERIMENTS ON STAINLESS STEEL WITH SPECIAL CONSIDERATION OF THE UTILIZATION IN THE HEAVY WATER REACTOR DIORIT. A. F. Steinegger (Institut fur Reaktorforschung, Wurenlingen, Switzerland). Neue Tech., 2: No. 12, 8-18(Dec. 1960). (In German)

Over 40 series of experiments were carried out in order to find the factors affecting the pickling of unstabilized austenitic stainless steel (type 18/8) without molybdenum. These experiments showed that the most important factors are the carbon content and the metallurgical stage of the material. The data found for acid concentrations, temperature, time of pickling, and flow rate were used for the cleaning and pickling of the piping of the Swiss heavy water reactor Diorit. A summary is made of the conditions giving a very good cleaning and pickling as a result of the pickling experiments and the practical experience. (auth)

14657 MASS SPECTROMETRIC ANALYSIS OF GAS EVAPORATION IN TANTALUM AND NIOBIUM SINTERING. V. M. Amosov and V. A. Lanis (Electric Tube Factory, Moscow). Zhur. Priklad. Khim., 34: 84-9(Jan. 1961). (In Russian)

The quantitative and qualitative variations in composition of the gas phase in tantalum and niobium sintering were studied. The data are useful in selecting suitable conditions for sintering other powders. (R.V.J.)

Corrosion

14658 (MND-E-2145) MARTIN-ANPP CORROSION TESTING PROGRAM METHODS AND PROCEDURES. (Martin Co. Nuclear Div., Baltimore). Feb. 1961. Contract DA-44-009-ENG-3581). 89p.

Methods and procedures utilized in the ANPP Corrosion Test Program are outlined. Those methods which are common to all tests within the program or which are unique are described. Physical descriptions, and startup and operating procedures for the rocking autoclaves and for primary and secondary systems of the corrosion loop are given. Physical descriptions and fabrication techniques for test specimens, including various types of autoclave specimens, and model and miniature heat exchangers, are covered. Pre-test and post-test evaluation techniques are described. Sampling procedures and chemical analysis techniques are outlined. A method for determining the temporal behavior of the heat transfer characteristics of the vessels is covered. A flow and instrumentation diagram of the corrosion loop as well as electrical schematic diagrams are included. (auth)

14659 (TID-11933) RATE OF DISSOLUTION, ELECTROCHEMICAL AND PASSIVATION STUDIES OF ALPHA ZIRCONIUM–OXYGEN SOLID SOLUTIONS IN HYDROFLUORIC ACID. Progress Report [on] CORROSION OF NUCLEAR METALS. W. J. James, M. E. Straumanis, and W. G. Custead (Missouri. Univ., Rolla. School of Mines and Metallurgy). 1961. Contract AT(11-1)-73. 15p.

Studies were conducted on the mechanism of dissolution of alpha solid solution specimens of oxygen in zirconium in HF–HCl mixtures. A rate order of one and an average activation energy of 4.7 kcal was found for Zr in ZrO_x. ZrO_x specimens dissolving in HF–HCl mixtures exhibited a positive difference effect similar to that observed for zirconium and hafnium. The K values (mm^3/ma min) increased with increasing oxygen content, suggesting that dissolved oxygen might be responsible for the remarkable anodic polarization of zirconium and related metals. The shift toward noble potentials upon addition of Pt^{4+} was in accord with the difference effect measurements. It is concluded that, as with zirconium and hafnium, the slow step is one of diffusion of molecular HF to the metal surface where the high rate of dissolution is due to direct chemical reaction outside of the action of local currents. (auth)

14660 (TID-11934) ANALYSIS OF TITANIUM METAL ALLOYS CONTAINING SMALL PERCENTAGES OF NITRO-

GEN AND OXYGEN. Progress Report on CORROSION OF NUCLEAR METALS. W. J. James, A. V. Martin, and M. E. Straumanis (Missouri. Univ., Rolla. School of Mines and Metallurgy). 1960. 9p.

A study is presented on the mechanism of the reaction of titanium containing small percentages of nitrogen and oxygen with hydrofluoric acid. The study entailed the development of analytical techniques for the determination of nitrogen and oxygen in sintered samples. A study was also made of the effects of sintering upon the oxygen and nitrogen content. (W.L.H.)

14661 (TID-12268) COMPATIBILITY OF MATERIALS IN LIQUID METAL AND COMPOSITION 30. H. P. Leeper (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Mar. 26, 1956. Decl. Sept. 18, 1959. 29p. (TIM-251)

Data are presented for compatibility tests of various material combinations under conditions of static or rubbing contact in 1500°F NaK and 1200 to 1500°F ORNL No. 30 fluoride salt. The materials used in the tests included metals, cermets, and ceramics. W, Co-bonded WC, and Fe-, Co-, and Ni–Mo-bonded TiC cermets were found to be resistant to corrosion by NaK; ceramics, except possibly BeO, are not resistant to NaK. Ni- and Co-base alloys, Ag, Au, Pt, and WC and TiC cermets with Ni and Co binders are fairly resistant to No. 30 salt, while Fe-base thermanols are not. Surface film formation reduces the tendency to weld in static tests. In NaK, metal-metal or metal-cermet combinations will weld together unless a surface film is formed before contact is made. Ni-base alloys are not resistant to welding to other metals and cermets in No. 30 salt or NaK, while WC–TiC cermets are weld-resistant in No. 30 salt. The combinations Mo–WC in NaK and Mo–Mo and TiC–WC are weld-resistant and exhibit small surface roughness changes in No. 30 salt. Metal-metal combinations and ceramics are not compatible in dynamic tests in both NaK and No. 30 salt. One combination, Mo–WC, shows promising dynamic compatibility in NaK. (D.L.C.)

14662 (WAPD-ZH-27) ZIRCONIUM HIGHLIGHTS. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Feb. 1961. Contract AT-11-1-GEN-14. 21p.

Four papers are included which treat the corrosion of Zircaloy-2 and -4 and the effects of hydrogen content on their strength. Separate abstracts have been prepared for each of the papers. (D.L.C.)

14663 (WAPD-ZH-27(p.1-7)) SOLUTION AND DIFFUSION OF CORROSION OXIDE FILM IN ZIRCALOY. R. M. Treco (Olin Mathieson Chemical Corp., [New Haven]).

The formation of a corrosion oxide film on Zircaloy-2 and its diffusion into the interior under both normal and annealing conditions were studied. The contribution of the oxide film to the oxygen concentration in the Zircaloy-2 after annealing was determined. It is concluded that annealing followed by pickling will remove the corrosion film and leave Zircaloy-2 with a clean surface. (D.L.C.)

14664 (WAPD-ZH-27(p.8-11)) EFFECT OF ENVIRONMENT ON CORROSION AND HYDROGEN PICKUP BY ZIRCALOY-2 AND ZIRCALOY-4. W. W. Kirk and S. Kass (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Specimens of Zircaloy-2 and -4 were exposed to 750°F steam for 42 and 56 days and then tested in 600 and 680°F water, respectively, for weight gain and hydrogen pickup. The corrosion results show, after an initial memory effect, a corrosion rate similar to those of specimens continuously exposed to water, verifying the transfer method of determining post-transition corrosion rates of Zircaloy alloys. Post-transition corrosion rates were calculated by extrapolation of the results. The hydrogen pickup data contradict the assumption that the process is independent of the medium temperature. (D.L.C.)

14665 (WAPD-ZH-27(p.15-19)) EFFECT OF COPPER PLATING AND DIFFUSION ANNEALING ON THE CORROSION RESISTANCE OF ZIRCALOY-2 AND ZIRCALOY-4. J. D. Goodwin (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The effects of copper plating and subsequent diffusion annealing on the corrosion behavior of Zircaloy-2 and -4 were studied by plating one surface of 0.050-in. thick strips with 0.0002 in. of copper, soaking the coupons at 1010°C for 4 hr, and either furnace cooling or water quenching. A control group of coupons was similarly heat treated but not copper plated, and as-received material was also tested in the corrosion tests which were run for 140 days in 750°F 1500 psi steam or for 224 days in 680°F 2700 psi water. The results show that Zircaloy-4 is similar to Zircaloy-2 in its corrosion behavior in the as-received condition, that Zircaloy-4 coupons have better corrosion resistance except in the copper-plated, water-quenched condition, that the as-received condition and beta-quenched Zircaloy-4 have the best corrosion resistance, and that copper plating followed by a diffusion anneal in the beta phase reduces the corrosion resistance of both alloys regardless of the cooling method. (D.L.C.)

14666 (NASA-TT-F-59) MECHANISM OF THE OXIDATION OF NICKEL AND CHROMIUM ALLOYS. D. V. Ignatov and R. D. Shamgunova. Translated from the Russian Version, published in Moscow, 1960. 104p.

The principal methods of investigating the oxidation process of metals and alloys in gaseous media at increased and high temperatures (400 to 1050°) are described. The main results of experimental works on the investigation of the oxidation kinetics and on the structure and composition of oxide films are described. Modern theories of the oxidation of metals and alloys are reviewed, and the possibility of using them to explain the oxidation mechanism of Ni–Cr alloys is considered. (auth)

14667 THE APPLICABILITY OF ALUMINUM AND ALUMINUM ALLOYS IN THE CONSTRUCTION OF WATER-COOLED REACTORS. G. Saur, W. Reinsch, and H. Borchers (Technische Hochschule, Munich). Atomkernenergie, 6: 30-6(Jan. 1961). (In German)

There are chiefly two difficulties in the use of aluminum and aluminum-alloys in water-cooled reactors: the low corrosion resistance at temperatures above 200°C and the low strength at high temperatures. The heavy attack by high-temperature water on aluminum and its common alloys is discussed. The effects of alloying elements on aluminum and the effects of radiation, P_H value of water, the velocity of flow, and pressure are described. A discussion of the influence of alloying elements on strength and cross sections shows that the absorption index is a function of strength. The concentration of elements of higher cross sections than aluminum must be as low as possible. Using a new diagram for finding the absorption index of metals, aluminum, zirconium, and steels are compared. The limits of the compatibility of aluminum and its alloys are shown. (auth)

14668 PRACTICALITY OF ESTABLISHING THRESHOLD VALUES TO ELIMINATE STRESS CORROSION

FAILURES IN METALS AND ALLOYS. Henry Suss (Knolls Atomic Power Lab., Schenectady, N. Y.). Corrosion, 17: 61t-6t(Feb. 1961).

A review is offered on the significance of many factors which could affect the stress corrosion behavior of materials. These include such items as method of test, variations normally present in the materials conforming to the same specification, slight variations in test environment or metallurgical structure of the metal, accelerated corrosion attack (galvanic or crevice), residual stress, and nature of corrosion attack. Based on this review, it was evident that all the factors do not act independently; instead, there is a complex mutual interaction. As a result of these factors, it was concluded that the stress corrosion problem cannot be entirely eliminated at this time through control of specific parameters to established threshold values. The recommended approach is selection of an alternate resistant material. Other approaches to minimize the problem are proper design, reduction of the corrosivity of the environment, reduction of effective stress, or use of a protective layer. Evaluation under actual service conditions is an essential requirement. The possible danger of localized failure or increasing porosity of a protective layer with continued exposure of the base metal also is emphasized. Special attention is given to the behavior of AISI 410 steel. (auth)

14669 CORROSION PRODUCT FILMS FORMED ON ALUMINUM IN HIGH TEMPERATURE WATER. D. F. MacLennan (Naval Research Establishment, Dartmouth, Nova Scotia). Corrosion, 17: 181t-4t(Apr. 1961).

A study was made of the behavior of aluminum alloys exposed to 300°C high purity water for short periods of time. The corrosion products formed were examined by means of optical and electron microscopy. Results show that corrosion resistance is associated with the distribution of second phase particles in the alloys. The alloy, which had the best corrosion resistance, contained the most uniform distribution of cathodic second phase particles; the corrosion product film of this alloy contained a corresponding distribution of irregularities. It is suggested that the second phase particles modify the film in such a way as to increase its protective qualities. (auth)

14670 INTERGRANULAR CORROSION OF COMMERCIALLY PURE ZIRCONIUM. Burton S. Payne, Jr. and David Kenneth Priest (Pfaudler-Permutit, Inc., Rochester, N. Y.). Corrosion, 17: 196t-200t(Apr. 1961).

Selective corrosion in a hot hydrochloric acid service was noted in a narrow band of the heat affected zone of a commercially fabricated zirconium weldment. Little attack was present on the weld proper or the parent stock. The selective attack was found to be intergranular in nature and associated with the presence of a precipitated phase in the grain boundaries. The particular precipitated phase required for this attack was duplicated in bulk samples by specific heat treatment, as well as in experimental weldments. Two methods of prevention of this localized attack near welds were evaluated; namely: use of high purity zirconium, and heating of commercially pure zirconium weldment at 1800°F followed by a water quench. Possible mechanisms for the microstructural changes and for the corrosion attack are discussed. (auth)

14671 OXIDATION OF METALS. W. W. Smeltzer and J. M. Perrow (McMaster Univ., Hamilton, Ont.). Ind. Eng. Chem., 53: No. 4, 319-24(Apr. 1961).

Oxidation theories and measurements are reviewed. Three tables are given that list oxides, metals, and alloys with references to oxidation studies. The review covers articles written to November 30, 1960. Special emphasis is placed on reference to work on diffusion and interfacial controlled reaction kinetics, structures, lattice defect types, and transport phenomena. (N.W.R.)

14672 CIRCULATING FUSED-SALT FUEL IRRADIATION TEST LOOP. D. B. Trauger and J. A. Conlin, Jr. (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 9: 346-56(Mar. 1961).

A compact forced-circulation test loop for obtaining corrosion data applicable to molten-salt-fueled reactors were operated in the MTR (HB-3) beam hole. Several tests were conducted with two fused-salt mixtures, $NaF-ZrF_4-UF_4$ and $Li^7F-BeF_2-UF_4$, in loops constructed, respectively, of Inconel and INOR-8 (nominal composition: 70% Ni, 16% Mo, 7% Cr, 5% Fe, 2% other alloying elements). The maximum loop temperature ranged from 1300 to 1600°F. Engineering aspects of loop design and operation are described. (auth)

14673 IMPROVEMENTS IN PROTECTING ALUMINUM ALLOYS AGAINST CORROSION. (to Atomic Energy of Canada Ltd.). French Patent 1.204.092. Aug. 3, 1959.

The rate of corrosion of Al–Ni alloy fuel cans containing 0.5 to 2.5% nickel, 0.5 to 1% iron and 0.1 to 0.2% silicon and which are cooled by water at 150 to 350°C is greatly reduced by adding 800 to 1000 ppm SiO_2 to the coolant. The pH of the latter should be at least 5. The SiO_2 can be added as a soluble silicate, the cation being removed by ion exchange. Preferably the cans are given a pretreatment in the stagnant coolant during at least one day in order to create a protective aluminum silicate layer on their surface. (NPO)

Fabrication

14674 (CEND-93) A PROGRAM TO STUDY THE FEASIBILITY OF AND DEVELOP AN APPARATUS FOR THE ULTRASONIC ROLL BONDING OF FUEL PLATES. Summary Report for Period June 15, 1959 to August 15, 1960. (Combustion Engineering, Inc., Windsor, Conn. and Aeroprojects, Inc., West Chester, Penna.). Dec. 1960. 129p. Contract No. AT(30-1)-2379.

The program was restricted to the production of flat, plate-type bond specimens. The cladding and core materials investigated were aluminum alloy and austenitic stainless steel. Subsequently, cores consisting of U_3O_8 dispersed in aluminum were utilized. Studies were conducted to determine the equipment requirements for bonding the materials of interest and to evaluate their relative weldabilities. A method of overlapping seam welds was adopted for cladding core surfaces. Methods of surface preparation prior to welding were examined, and it was determined that a non-etching alkaline wash followed by a chromate rinse was most conducive to bonding and to good clad surface finish. Several approaches were made toward developing ultrasonic bonding equipment capable of sustained operation at high power, clamping force, and welding speed. Problems in the development of suitable equipment for fabricating ultrasonically roll-bonded specimens were greater than originally anticipated. Ultrasonic inspection of the final group of face bonded specimens indicated that non-bonds greater than $\frac{1}{16}$ inch in diameter were not present. Metallographic examination revealed that ~30% of the specimens contained non-bonds about .010 inches to .050 inches in diameter. The remaining 70% was either bonded or contained few unbonded regions. (W.L.H.)

14675 (DMIC-149) BRAZING FOR HIGH-TEMPERATURE SERVICE. H. E. Pattee and R. M. Evans (Battelle Memorial Inst. Defense Metals Information Center, Co-

lumbus, Ohio). Feb. 21, 1961. Contract AF33(616)-7747. 32p. (PB-151108)

Many of the important developments in brazing for service temperatures in excess of 600 F are summarized. Heating methods, filler metals, atmospheres, fluxes, and deoxidizing agents are discussed as they affect the brazing of heat-resistant metals and alloys. Attention was also given to specific brazing applications. (auth)

14676 (DMIC-150) A REVIEW OF BENDING METHODS FOR STAINLESS STEEL TUBING. C. T. Olofson (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 2, 1961. Contract AF33(616)-7747. 52p. (PB-151109)

The applications and limitations of ram bending, roll bending, rotary compression bending and rotary draw bending in bending stainless steel tubing are discussed. Large-diameter, thin-wall tubing may be bent without buckling to a 2D minimum bend radius using draw bending and conventional but modified bending tools. In addition, complex and 180-degree bends could be fabricated in one piece. An integrated group of bending, pressure, wiper, and clamp dies, a multiball mandrel, and a clamp plug were used for forming the single bends. Special tooling was needed for compound and multiple bends. Individual tools were made to precise dimensions and with smooth surface finishes. Advantages accrued when tight single bends and one-piece complex bends are produced in large-diameter, thin-wall tubing include weight reductions, stronger duct structures, and improved gas-flow characteristics, as well as economy of time, material, and labor. (auth)

14677 (HW-63558) FABRICATION OF 10 WEIGHT PER CENT PLUTONIUM-ALUMINUM MONITORING FOILS AND PIN. R. E. Sharp and L. C. Lemon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1960. Contract AT(45-1)-1350. 24p.

The fabrication of a special 10 wt.% Pu–Al alloy pin enclosed in double aluminum cans and a number of nickel-canned 10 wt.% Pu–Al alloy wafers for reactor physics studies is described. The fabrication techniques for the foils described in detail include: the casting of the alloy billet; rolling; punching out wafers and the method of taking analytical samples; measuring, weighing and bottling wafers; can and lid fabrication; tinning operation; canning and spot welding; leak testing; and identification marking. The fabrication method for the pin includes the development of molds and casting techniques, radiographing, machining of the pin and segregation check, canning and welding of closure, and leak testing methods. All operations using bare Pu–Al alloys were carried out in either glove boxes or open-front hoods. (auth)

14678 (LA-2480) BOTTOM-POUR RE-USABLE MELTING CRUCIBLES FOR PLUTONIUM CASTING. Frank Miley and J. W. Anderson (Los Alamos Scientific Lab., N. Mex.). Oct. 1960. Contract W-7405-ENG-36. 24p.

Bottom-pour Ta and CaF_2-coated steel melt crucibles for Pu and Pu-rich alloys were developed. The controlled pour is effected by melting a Pu plug in the bottom spout of the crucible after the desired temperature and vacuum conditions are obtained. A description is given of the development of the crucibles which have replaced ceramic crucibles for casting work on the kilogram scale. (auth)

14679 (NP-9915) DEVELOPMENT OF TANTALUM–TUNGSTEN ALLOYS FOR HIGH PERFORMANCE PROPULSION SYSTEM COMPONENTS. Quarterly Report No. 6, period covered July 10–October 9, 1960. M. L. Torti (National Research Corp., Cambridge, Mass.). Contract NOrd-18787. 31p.

Work was continued on fabrication procedures for tantalum-tungsten alloys and tantalum-carbide-coated tantalum components for rocket motors. Oxidation protection studies were made using aluminum coatings, Corning 100-mesh glass in a water slurry, and pure tantalum. Hammer, full-scale, and press forging studies are described. A study was initiated to determine whether additional purification can be obtained by yttrium additions. Fabrication and micro-structure studies were conducted of 10%-hafnium-tantalum alloys and 10%-hafnium-tantalum-5%-tungsten alloys. The alloying effects of carbon and zirconium on tantalum-10%-tungsten mechanical properties were investigated. (B.O.G.)

14680 (NP-9958) BERYLLIUM CASTING, PHASE II. Final Report, September 19, 1958–December 15, 1960. Kenneth C. Taber and R. C. Harris (Beryllium Corp., Reading, Penna.). Contract AF33(600)-37902. 60p.

A reliable technique for producing fine-grained, sound beryllium cast ingots was developed. Four approaches to obtain grain refinement were evaluated including; alloying additions, inoculation, mold vibration, and accelerated cooling through mold design. Of these, the latter was the most effective in achieving sound, fine-grained ingots. The alloying additions in varying amounts of lanthanum, zirconium, germanium, and silver were evaluated for grain refinement effects. Five ingots were poured with lanthanum additions of 0.07% to 0.5%. Ingot XP-183 with 0.07% lanthanum produced the lowest average grain size of 0.115 (mm) in this series. Thirteen ingots containing zirconium additions from 0.15% to 2.43% were evaluated. Ingot XP-186 in this group with 0.27% zirconium had a low average grain size of 0.097 (mm). Eleven germanium alloy castings were poured with germanium concentrations of less than 15 ppm to 0.69%. In this series ingot XP-96, having 0.13% germanium, had the lowest average grain size of 0.101 (mm). The silver alloy series included six castings. The amount of silver additions varied from 0.23% to 16.1% with ingot XP-89 (4.94% silver) having the lowest average grain size of 0.137 (mm). The zirconium alloy containing 0.27% zirconium, poured at 1350°C into a cold 1.5-in. diameter mold produced the lowest average grain size. Other alloying elements including aluminum, titanium, silicon, and silver were used either singly or in combination to evaluate their effect on surface finish, apparent fluidity of the melt, and ingot soundness. Fifteen heats were poured. The silicon and titanium in combination produced good fluidity and sound castings were produced using a combination of titanium, silicon, and silver. Tantalum nitride and tungsten carbide were found to be ineffective as inoculants, in the concentrations obtained in the eighteen melts poured. The use of a low frequency mechanical vibration of the mold produced grain refinement in six ingots poured. The study suggests that a higher energy in either frequency or amplitude would be beneficial in breaking up the columnar grains as they grow during solidification. The use of heavy-walled molds made of high thermal conductivity materials to control solidification rates was most effective in achieving sound, fine-grained ingots. Three fine-grained ingots were extruded at a reduction ratio of 4.5:1. The first ingot containing 0.76% silver was poured at 1300°C. The second contained 1.22% silver and was poured under the same conditions. The third ingot was unalloyed beryllium poured at 1400°C. No vibration was used on the molds of these ingots. Sections of the first two extrusions were clad and subsequently rolled to 0.090 sheet. Metallographic examination of the sheet indicated that a recrystallized structure can be

produced which is equiaxed and has a grain size comparable to hot-pressed beryllium powder. (auth)

14681 (NP-9987) ELECTROPLATING ON MAGNESIUM AND BERYLLIUM. An Annotated Bibliography. Robert C. Gex, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Feb. 1961. 32p. (SB-61-4)

An annotated bibliography on electroplating on magnesium and beryllium and their alloys is presented. Pretreatment of surfaces for electroplating and testing of electroplated surfaces is included. The sources were: Chemical Abstracts 1930 to present, Engineering Index 1930 to present, Review of Metal Literature 1944 to present, Nuclear Science Abstracts 1946 to present, Metallurgical Abstracts 1951 to present, the PAL Uniterm Index, LMSD TIC Catalogs, and ASTIA. (T.R.H.)

14682 (ORO-371) SYNTHESIS AND FABRICATION OF REFRACTORY URANIUM COMPOUNDS. Monthly Progress Report No. 11, November 1–November 30, 1960. K. M. Taylor and C. H. McMurtry (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). Dec. 13, 1960. Contract AT(40-1)-2558. 3p.

Batches of UC were synthesized for use in fabrication of specimens for physical property determinations. This synthesis was carried out with mixed loose powders in a graphite crucible. Two and one-half pound batches of UN were synthesized using a stainless steel boat and an Inconel muffle furnace. Three batches of U_3Si_2 were synthesized with particular emphasis on controlling the rate of the reaction by limiting the maximum temperature to 1500°C. In addition, determinations were made of modulus of rupture, shear modulus, and Poisson's ratio of sintered UC, UN, and U_3Si_2 specimens. (M.C.G.)

14683 (SB-61-2) ULTRASONIC WELDING. An Annotated Bibliography. Maureen A. Pearcy, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Feb. 1961. 25p.

A review of recent unclassified literature on the application of ultrasonic vibrations to the welding of various materials is presented. The sources checked for this material include: holdings of Lockheed Missiles and Space Division Technical Information Center; ASM, Review of Metal Literature, 1959 to 1960; Engineering Index, 1958 to 1961; Crerar Metals Abstracts, 1958 to 1960, Nuclear Science Abstracts, 1958 to 1960; and the Russian journals Automatic Welding and Welding Production in translation. (auth)

14684 (SB-423) POWDER METALLURGY (SUPPLEMENT TO CTR-343). OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Aug. 1960. 10p.

A bibliography is presented including PB reports, AEC reports, and translations on powder metallurgy, as well as related reports on sintering, added to the OTS collection during the period May 1958 to September 1960. (auth)

14685 (TID-6172) A METHOD FOR THE ATTACHMENT OF METALLIC PROBES TO INTERMETALLIC-TYPE THERMOELECTRIC MATERIALS. W. A. Owczarski (Knolls Atomic Power Lab., Schenectady, N. Y.). May 26, 1960. Contract W-31-109-ENG-52. 3p.

A technique was developed for the direct attachment of chromel and alumel wires to Bi_2Te_3, PbTe, and ZnSb for operation at high temperatures. In this technique, a wire is beaded and then inserted into a pin vise which brings the wire to bear down on the thermoelectric material with a light load of a few ounces. A low-intensity current impulse is passed through this interface, melting the thermoelectric material and causing the wire to sink into the melt to form a strong joint. Platinum–10% rhodium, iron, and constantan can also be attached to these three thermoelectric materials in this way. (D.L.C.)

14686 (TID-12325) THE DESIGN OF WELDMENTS AND THE MAKING OF WELDS. Success Depends on Recognition of Complex of Interrelated Factors. W. L. Fleischmann (Knolls Atomic Power Lab., Schenectady, N. Y.). [1961]. 7p.

For presentation at Meeting of American Welding Society, Chattanooga, Tenn., February 23, 1961.

Some of the problems of welding of type 347 stainless steel are discussed, and investigations made on these problems are reviewed. It is concluded that precipitation of Nb carbide is responsible for rupture failure in service. High residual welding stresses cause failures in post-weld heat treatment. Aging of solution-treated material at 900°C should permit successful welding. (D.L.C.)

14687 (AEC-tr-4524) CRITERION OF PLASTICITY IN THE PRESSURE TREATMENT OF METALS. M. A. Zaikov and V. N. Peretyat'ko. Translated from Izvest. Vysshikh Ucheb. Zavedeniĭ: Chernaya Met., No. 8, 75-86(1959). 15p.

The different criteria of plasticity of metals are reviewed critically, and it is concluded that a dependable criterion of plasticity can be obtained based on two indexes, one determined under conditions of negative hydrostatic pressure and the other under conditions of positive hydrostatic pressure. Relevant equations are given. Plasticity curves calculated from literature data are presented for nickel and stainless steel. The criterion of plasticity can be used to determine the temperature range of maximum plasticity and the ultimate deformation in various methods of working metals by pressure. (D.L.C.)

14688 (NP-tr-596) THE HEAT RESISTANCE OF WELDED JOINTS OF NICKEL–CHROMIUM ALLOY TYPE Kh2ON8OT3Yu (E1437B). B. I. Medovar, A. N. Safonnikov, and P. O. Lents. Translated from Avtomat. Svarka, No. 2, 3-19(1959). 35p.

It is shown that during automatic arc welding and arcless molten slag welding of a nickel-chromium alloy EI437B with fluoride, oxygen-free fluxes, high heat resistances were attained in the welded joints. The effects of the length of the heating stage of heat-hardening and of cold working on the rupture strength of the welded joints were determined. (auth)

14689 THE PROBLEM OF WELDING HIGH TEMPERATURE SERVICE MATERIALS. E. Kauhausen, P. Kaesmacher, and S. Sadowski (Böhler Bros. & Co., Dusseldorf, Germany). Brit. Welding J., 7: 693-707 (December 1960).

Investigations were made on the welding of ferritic steels for high-temperature service, containing 1.0 to 9.0% chromium and 0.5 to 1.0% molybdenum. The properties of joints made by various welding processes are described. The differences between basic lime-coated and acid rutile-coated electrodes are examined, in respect to their welding characteristics and economy. The need for proper preheating of the base material and subsequent stress-relief heat treatment of the welded joint is discussed. The welding of 12% chromium steel is examined, and it is shown that by the use of electrodes with similar composition to that of the base material and by close attention to the heat-treatment procedure satisfactory welded joints can be produced. In welding fully austenitic stabilized steels, cracking is a considerable problem, and its causes are investigated. It is shown that high-quality welds can be produced by using 16% chromium–13% nickel–6% cobalt electrodes which produce a stabilized

deposit. The possibilities of welding austenitic and ferritic steels with nickel alloy electrodes are discussed. (auth)

14690 FURTHER DEVELOPMENT OF A TECHNIQUE FOR THE PREPARATION OF METALLOGRAPHIC SPECIMENS OF ZIRCALOY. A. Bassi and C. Corsetti (CISE, [Milan]). Energia nucleare (Milan), 8: 149-50(Feb. 1961). (In English)

Etching solutions of two types are described for removal of perturbed surface layers of atoms from Zircaloy samples, following fine polishing with diamond paste. One of the solutions contains nitric acid, water, hydrofluoric acid, and acetic acid; the other solution contains nitric acid, water, hydrofluoric acid, and chromic acid. Etching time varies from 1.5 to 4.0 min, depending on the metal sample. An anodization technique is also described for use with fine-grained alloys which are insensitive to polarized light. An anodizing solution, containing water, acetic acid, sulfuric acid, glycerine, and chromic anhydride is prepared; the sample is anodized in this solution from 2 to 4 sec, at 20 to 60 v. This process improves grain contrast under polarized light. (T.F.H.)

14691 METHODS OF TARGET PREPARATION. H. P. Hänni (Rice Inst., Houston, Tex.). Helv. Phys. Acta, 33: 987-91(1960). (In English)

The criteria for a good target for the study of nuclear reactions are tabulated. The procedures for target preparation are then classified and briefly discussed. The types of procedures reviewed are vacuum evaporation, cathode sputtering, electrochemical process, vapor plating, electromagnetic isotope separation, and the sintering method. (J.S.R.)

14692 THERMAL DISTORTION IN STEEL PLATES FOR A PROTON SYNCHROTON MAGNET. R. J. Wakelin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Research (London), 14: 100-6(Mar. 1961).

An account is given of the difficulties encountered during the annealing of large steel plates for a proton synchrotron magnet. These difficulties were overcome by a mixture of higher mathematics, careful experimentation, and common sense interpretation. (auth)

14693 VACUUM-ARC EVAPORATION OF REFRACTORY METALS. M. S. P. Lucas, H. A. Owen, Jr., W. C. Stewart, and C. R. Vail (Duke Univ., Durham, N. C.). Rev. Sci. Instr., 32: 203-4(Feb. 1961).

A method of reducing contamination in the production of high-purity vacuum-evaporated refractory metal films by increasing the deposition rate is discussed. A consumable-electrode vacuum-arc furnace was used. Films were obtained using niobium, tantalum, vanadium, and stainless-steel electrodes. (M.C.G.)

14694 ULTRASONIC WELDING. ENGINEERING, MANUFACTURING AND QUALITY CONTROL PROBLEMS. J. Koziarski (Martin Co., Denver). Welding J. (N. Y.), 40: 349-58(Apr. 1961).

Ultrasonic welding is a new process for joining dissimilar and refractory metals in spacecraft. In this process there is no melting, cast nugget, significant diffusion, recrystallization, grain growth, grain boundary depletion or formation of brittle intermetallic compounds. Ultrasonic welding may be used for economy purposes or where other joining methods either fail or are impractical. The process provides joint strength that sometimes is considerably greater than that obtained with conventional resistance welding. The consistency of ultrasonic welding is good. In contrast to other welding methods the material degradation is insignificant. However, ultrasonic welding should not be considered as a cure-all. Rather, it will complement other joining processes. (auth)

14695 BRAZING OF SANDWICH STRUCTURES OF COLUMBIUM ALLOYS. M. M. Schwartz (Martin Co., Baltimore). Welding J. (N. Y.), 40: 377-82(Apr. 1961).

A recently developed cold-wall, high-temperature, internal-element vacuum furnace was used for brazing sandwich structures of Nb alloys at 4000°F. Results indicate that a ductile and strong joint at 3000°F is possible. Pure Ti appears to be the optimum braze alloy for Nb with 33% Ta and 0.7% Zr. (N.W.R.)

14696 PROCESS FOR THE MANUFACTURE OF METAL INGOTS. (to Sylvania-Corning Nuclear Corp.). French Patent 1,206,681. Aug. 31, 1959.

An improved process is described for the manufacture of ingots of U, Th, Pa, Zr, Be, or their hydrides. The metals in powder form are brought into a tube-shaped mould, then put under pressure between 4350 and 14500 kg/cm^2 at temperatures between 450 and 660°C. The resulting ingots or billets have nearly the density predicted by theory. If a nuclear fuel element with a container is wanted, a closely fitting tube of Al, Be, or Zr is inserted in the mould. The metal powder is then introduced and sealed at both ends by discs of the same metal as the container, and the material is pressed at the correct temperature. A wholly and tightly contained fuel element results. (NPO)

14697 PROCESS FOR SOLDERING METALS. (to Sylvania-Corning Nuclear Corp.). French Patent 1,209,203. Sept. 21, 1959.

A method is described that enables the connection of two different metals or alloys, e.g. U and Al, under pressure at temperatures below the melting points of the components. To this end a thin layer of Ni is placed between the two metals, and the "sandwich" is pressed for ~6 min at 2109 kg/cm^2 at a temperature of 550°C in a protective atmosphere. (NPO)

Properties and Structure

14698 (AGN-8027) SPACE POWER SYSTEMS TECHNOLOGY STUDIES. RUBIDIUM EVALUATION PROGRAM. Report No. 12. Quarterly Technical Progress Report for Period November 1, 1960 through January 31, 1961. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AT (04-3)-251. Project Agreement No. 5. 23p.

A stainless steel loop test with liquid rubidium was run for 172 hr, and the design temperature of 1550°F at ~15% vapor quality rubidium in the boiling phase was achieved. The problems of loop operation are discussed, e.g., trapped gas bubbles and argon leakage from the argon-to-water heat exchanger. The rubidium was made to boil, and its boiling point was determined to be 1325°F at 33 psia and 1450°F at 60 psia. The discrepancy between measured and literature boiling points is probably due to the fact that the thermocouples did not measure the actual rubidium temperature. The density of rubidium was measured at several temperatures from 175 to 1340°F and compared with literature values. (D.L.C.)

14699 (BMI-1500) DEVELOPMENT OF CONTAINER MATERIALS FOR LAMPRE APPLICATIONS. David C. Drennen, Merritt E. Langston, Charles J. Slunder, Joseph G. Dunleavy, and A. M. Hall (Battelle Memorial Inst., Columbus, Ohio). Feb. 14, 1961. Contract W-7405-eng-92. 46p.

Some 83 high-purity binary tantalum-base alloys were prepared and evaluated as candidate materials of construc-

tion for the Los Alamos Molten Plutonium Reactor Experiment. Preliminary data indicate that good resistance to attack by the fuels can be obtained by alloying tantalum. Alloys containing additions of rhenium and tungsten showed good corrosion resistance in polythermal (1382 to 1022°F) tilting-furnace exposures. Tantalum–yttrium alloys also displayed good corrosion resistance, even though the yttrium apparently was lost during arc melting. Most of the alloys, including those which showed good corrosion resistance, were amenable to arc melting and casting and fabrication at room temperature. (auth)

14700 (BNL-5214) THEORY OF ANNEALING OF VACANCIES AND DIVACANCIES IN PURE METALS. G. J. Dienes and A. C. Damask (Brookhaven National Lab., Upton, N. Y.). [1961]. 25p.

For presentation at Faraday Society Meeting at Saclay, France, April 11-12, 1961.

The kinetic equations for the simultaneous annealing of mono- and divacancies, including the formation and dissociation of divacancies, were examined both analytically and on an analog computer. Five regions of different kinetic behavior were found as a function of annealing temperature, and the range of validity of these regions is a sensitive function of the quench temperature. One of these regions is the simple decay of quenched-in divacancies, while the other four involve interactions between mono- and divacancies. Useful analytic approximations were made for two of these regions, a quadratic decay and a quadratic plus linear one, both of which were observed experimentally. Initial decay in annealing, also observed experimentally, is shown by the machine solutions but cannot be approximated analytically. This decay is related to the buildup of divacancy concentration (which goes through a maximum) and is favored by high divacancy binding energy, high initial vacancy concentration, and low divacancy mobility. The annealing curves, in general, cannot be normalized with respect to initial defect concentration. Difficulties in obtaining divacancy migration energies are discussed. (auth)

14701 (CEA-1662) ETUDES SUR L'EVOLUTION DES STRUCTURES CRISTALLINES DE L'URANIUM PAR NEUTROCRISTALLOGRAPHIE. (Studies on Determination of Crystal Structure of Uranium by Neutron Crystallography). Jacqueline Laniesse, Marcel Englander, and Pierre Meriel (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1960. 18p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 14096.

14702 (DMIC-147) THE FACTORS INFLUENCING THE FRACTURE CHARACTERISTICS OF HIGH-STRENGTH STEEL. C. W. Marschall (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 6, 1961. Contract AF 33(616)-7747. 39p. (PB-151106).

The various factors, both external and metallurgical, which affect the fracture characteristics of steel are discussed. (auth)

14703 (DMIC-148) REVIEW OF CURRENT DATA ON THE TENSILE PROPERTIES OF METALS AT VERY LOW TEMPERATURES. J. E. Campbell (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 14, 1961. Contract AF33(616)-7747. 76p. (PB-151107)

Current data on the tensile properties of metals to liquid-hydrogen temperature (–423°F) are summarized. In general, the yield strength, tensile strength, and elastic modulus of a given alloy were found to increase as the testing temperature decreased. The ductility tended to decrease as the testing temperature decreased. Face-centered cubic metals, some cobalt alloys, some titanium alloys, tantalum, and zirconium retained considerable ductility at very low temperatures. Reducing impurities, interstitial elements, and inclusion contents increased the ductility at –423°F. To minimize brittle fracture tendencies at very low temperatures, special precautions were taken in design and fabrication to avoid stress concentrations in equipment for low-temperature use. Results of tests on a number of aluminum alloys to –423°F indicated that there is some latitude for selection of these alloys for cryogenic applications. Copper-base alloys containing beryllium had sufficient toughness for use at –423°F. Some nickel- and cobalt-base alloys also retained considerable toughness for use at high temperatures. The low-temperature properties of heat-treated SAE 9310 steel indicated that this steel might be satisfactory for certain cryogenic applications. The austenitic stainless steels were found to have good strength and toughness at low temperatures. At very low temperatures, certain titanium alloys were found to have the highest strength-density ratios of any of the commercial metals used in cryogenic applications except for Type 301 stainless steel cold rolled 80%. (M.C.G.)

14704 (DMIC-Memo-88) ZINC COATINGS FOR PROTECTION OF COLUMBIUM FROM OXIDATION AT ELEVATED TEMPERATURES. W. D. Klopp and C. A. Krier (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 3, 1961. 21p. (PB-161238)

Zinc coatings may be applied to niobium by vacuum distillation at 1450°F, hot dipping at 1000 to 1300°F, aqueous electroplating, or cladding. A conditioning treatment consisting of about 16 hours at 1600°F in air is required to obtain maximum protection at higher temperatures. The service life of a properly conditioned 6-mil coating is about 1000 hours at 1800°F and 70 hours at 2000°F. The niobium-zinc intermetallics, which form during application and conditioning of the coating, decompose at 1892 to 2048°F. Zinc coatings exhibit remarkable self-repair properties and reduce or eliminate contamination hardening of the niobium substrate. The ability to repair relatively large defects is associated with the high zinc vapor pressure over the intermetallics. Zinc vapor oxidizes to ZnO over the defect, arresting the niobium-oxidation reaction, and reforms intermetallic layers under the oxide. Contamination hardening of the substrate is eliminated for 1000 hours at 1800°F by a 10- to 12-mil coating. Additions of 10% aluminum, 5% titanium, or 5% zirconium to the zinc improve the behavior of coatings applied by hot dipping. Zinc coatings are protective not only to niobium but also to niobium- and vanadium-base alloys. Zinc coatings are not protective to tantalum, molybdenum, or tungsten because zinc does not form intermetallics with these metals. (auth)

14705 (DMIC-Memo-89) SUMMARY OF PRESENT INFORMATION ON IMPACT SENSITIVITY OF TITANIUM WHEN EXPOSED TO VARIOUS OXIDIZERS. W. K. Boyd (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 6, 1961. 9p. (PB-161239)

The present status of the compatibility of titanium with LOX (liquid oxygen) and with other oxidizers such as N_2O_4, F_2, and ClF_3 is summarized. Considerable experimental evidence was obtained which indicated that, under certain conditions of impact, titanium and its alloys may ignite in strong oxidizers of the type used in rocket and missile propulsion systems. However, only in the case of LOX did there appear to be danger that the reaction would propagate and completely consume the titanium. In most cases, even though ignition occurred, the damage was not significantly greater than that occurring as a result of the impact alone. The data also suggested that the chance for a reaction can

be minimized if the titanium surface in contact with the oxidizer is smooth and surgically clean. In spite of its impact sensitivity, titanium appeared to have some areas of application where it can be used in contact with such strong oxidizers as LOX, fluorine, N_2O_4, ClO_3F, and H_2O_2. (auth)

14706 (DMIC-Memo-90) A REVIEW OF THE EFFECTS OF STARTING MATERIAL ON THE PROCESSING AND PROPERTIES OF TUNGSTEN, MOLYBDENUM, COLUMBIUM, AND TANTALUM. B. C. Allen (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 13, 1961. 37p. (PB-161240)

Recent information is reviewed which relates characteristics of the as-reduced refractory metal powders to the properties of the consolidated or fabricated product. The major impurities in these metals and their alloys are interstitials (C, O, N, and H), which make up ~½ of the total impurity content; however, these impurities and the more volatile metallic impurities are largely removed by consolidation via powder metallurgy, arc melting, or electron-beam refining. For W, control over powder size is important for proper compacting and sintering to permit direct working or arc melting. If Mo is hydrogen-reduced from ammonium molybdate or paramolybdate, a uniformly pure product is obtained, while erratic material containing objectionable metallics can result if molybdic oxide is used. Because Ta and Nb are soft and ductile, the purity and particle size of the raw powders have a minor effect on subsequent properties. (41 references). (D.L.C.)

14707 (DMIC-Memo-91) THE EMITTANCE OF TITANIUM AND TITANIUM ALLOYS. W. D. Wood, H. W. Deem, and C. F. Lucks (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 17, 1961. 28p. (PB-161241)

A compilation is given of test data taken from the literature from 1940 to 1960. The data were separated according to material and to type of measurement, whether spectral or total, for Ti, Al–Sn–Ti alloys, Mn–Ti alloys, Al–Ti–V alloys, and Ti–V alloys. (B.O.G.)

14708 (DMIC-Memo-93) A REVIEW OF RECENT DEVELOPMENTS IN TITANIUM AND TITANIUM-ALLOY TECHNOLOGY. R. A. Wood (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 27, 1961. 7p. (PB-161243)

Recent developments in Ti and Ti alloys are briefly reviewed which may influence their use in the future. The following topics are treated: markets for Ti, chemical reactions, corrosion, mechanical properties, high-strength alloys, and hardware. (15 references) (D.L.C.)

14709 (DMIC-Memo-94) REVIEW OF RECENT DEVELOPMENTS IN THE EVALUATION OF SPECIAL METAL PROPERTIES. J. E. Campbell (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Mar. 28, 1961. 8p. (PB-161244)

A review is given of recent developments in techniques relating to the evaluation of metals for very low-temperature service and studies of fracture toughness of high-strength metals. (B.O.G.)

14710 (KAPL-2078) PROTON RECOIL AS A SOURCE OF HYDROGEN IN REACTOR MATERIALS. A. H. Willis (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 31, 1960. Contract W-31-109-Eng-52. 8p.

Zircaloy-2 foils were irradiated and the hydrogen pickup measured. During one week in the Engineering Test Reactor in a fast neutron flux of 1.3×10^{14}, the pickup by a 2-mil-thick foil was 28 and 30 ppm. The predicted gain by proton recoil was 41 ppm, and that from corrosion, nil. Proton recoil is not considered to be a major factor in hydrogen pickup by zirconium in water-cooled reactors. (auth)

14711 (KAPL-2110) MECHANICAL PROPERTIES OF ZIRCALOY-2. R. L. Mehan and F. W. Wiesinger (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 1, 1961. Contract W-31-109-Eng-52. 47p.

The mechanical and physical properties of Zircaloy-2 were determined as a function of five test variables: temperature, grain size, direction to rolling, hydrogen content, and the presence or absence of a notch. The investigation included studies of the coefficient of thermal expansion, elastic modulus, tensile properties, creep properties, and low-cycle fatigue properties. Approximately 470 specimens from a single ingot were tested in the course of the investigation. (auth)

14712 (LMSD-288190(Suppl.3)) BERYLLIUM: A SURVEY OF THE LITERATURE. Kenneth D. Carroll, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 93p.

An annotated bibliography on beryllium, the third supplement to LMSC-288190, covering publications released during the final quarter of 1960 is presented. Citations are arranged alphabetically by author under the following subject headings: alloys, analysis, applications, compounds, bibliography, fabrication techniques, hazards, joining, oxides, powder metallurgy and casting, processing, properties, and miscellaneous. References to the use of beryllium in fuels, nuclear reactor applications, effects of radiation, and Cu–Be alloys are omitted. (auth)

14713 (MND-2455) A STUDY OF THE PROPERTIES AND FABRICABILITY OF AN IRON–ALUMINUM BASE ALLOY. Summary Report. J. Mueller (Martin Co. Nuclear Div., Baltimore). Dec. 1960. For General Nuclear Corp. Contract AT(38-1)-200, Subcontract 40-6-7. 28p.

A high-ductility, oxidation-resistant, aluminum–iron base alloy (designated Alloy 261) was selected for evaluation. Alloy 261 was prepared by vacuum melting and was cast into billets for rolling into sheet and for tube extrusion. Properties were determined in the unwelded and welded condition. Type 347 stainless steel was used for comparison in some tests. The tensile properties of Alloy 261 were determined at room temperature, 1000, 1200, 1350, 1500, and 2000°F. Fatigue tests were performed at room temperature and 1500°F, and the life limit used was two million cycles or failure. Notched and unnotched tensile impact tests showed the weld metal to be brittle, fracturing at room temperature at very low impact values. The transition temperature curves were determined for the welded alloy in the notched and unnotched condition, and the transition temperature was found to be between 200 and 400°F. The transition temperature for the unwelded alloy was below room temperature. Guided bend tests of welded Alloy 261 indicated the weld metal to be too brittle to withstand bending over a $\frac{5}{8}$-inch radius. Heating to 400–500°F permitted bends of $\frac{3}{8}$-inch radius but no smaller. A tube extrusion study indicated that 1600°F was a practical lower limit for extrusion of Alloy 261 for existing conditions. A similar alloy containing a smaller amount of niobium was satisfactorily extruded at 1500°F without reaching the limit of the machine. (auth)

14714 (NASA-TN-D-761) THE MELTING POINTS OF TANTALUM CARBIDE AND OF TUNGSTEN. Charles F. Zalabak (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Mar. 1961. 21p.

An experimental determination was made of the melting points in the tantalum-carbon system in the range of 4.26

to 5.60 wt.% carbon. The melting points ranged from 6360 to 6790°F. Though the starting material was of approximately the composition $TaC_{1.00}$, the stoichiometric carbide was not maintained even by the presence of a hydrocarbon atmosphere. A melting point of 6165°F was obtained for tungsten with a carbon content of 15 parts per million. Melting points of tungsten as low as 5790°F are attributed to carbon impurities in the region of 70 parts per million and the consequent lower solidus temperature for the tungsten–carbon solid solution. The temperatures are accurate to ±0.7% of the absolute temperature, based on the probable errors attendant to pyrometer calibration. (auth)

14715 (NP-9424) PHASE EQUILIBRIA BETWEEN B_2O_3 AND REFRACTORY OXIDES: THE SYSTEMS $BeO-B_2O_3$ AND $ThO_2-B_2O_3$. D. E. Rase (New York. State Univ. Coll. of Ceramics, Alfred). Aug. 1960. 15p. Project No. 7021. Contract AF33(616)-6545. (AD-235443)

The system $BeO-B_2O_3$ was found to have only one stable intermediate phase, $3BeO \cdot B_2O_3$, which melted above 1445°C. A tentative phase diagram is presented for the system $B_2O_3-ThO_2$. The system is characterized by extensive liquid immiscibility, the intermediate phase $B_2O_3 \cdot ThO_2$, and two eutectics. Selected interplanar spacings are reported for the stable phases in both systems. (See also AD-235443.) (C.J.G.)

14716 (NP-9873) INVESTIGATION OF THE EFFECTS OF PROCESSING VARIABLES AND FABRICATION TECHNIQUES UPON THE PROPERTIES OF INTERMETALLIC COMPOUNDS. Progress Report No. 3, October 1, 1960–December 31, 1960. Technical Report No. 197-229. R. Truesdale, B. B. Lympany, E. M. Grala, R. M. Paine, and W. W. Beaver (Brush Beryllium Co., Cleveland). Jan. 15, 1961. Contract AF33(616)-7108. 59p.

Investigations were conducted on the fabrication techniques of cold-pressing and sintering, and plasma flame-spraying for the compounds, $NbBe_{12}$, Nb_2Be_{17}, and Nb_2Be_{19}. Several processing variables for cold-pressed and sintered compacts of the niobium beryllides were studied in an attempt to achieve properties comparable to those of hot-pressed specimens. These variables were particle size, beryllium content, sintering atmosphere, temperature, time, and specimen size in relation to sintering temperature, density, grain size, and strength. Low strengths for the materials resulted from large grain sizes caused by long sintering times, high sintering temperatures, and low partial pressures of helium. Small particle sizes allowed use of lower sintering temperatures and broader sintering ranges, and resulted in higher densities and better reproducibility for cold-pressed and sintered samples. Hot-pressed billets of the niobium beryllides were upset to 70% in eight minutes at temperatures to 3000°F and pressures to 7500 psi in a vacuum hot press. The microstructures of the samples were relatively unchanged, although a small amount of grain growth occurred. All of the samples were annealed for one-half hour after upsetting to prevent fracture on cooling to room temperature. Of the three compounds upset, Nb_2Be_{19} had the highest resistance to deformation in vacuum. (auth)

14717 (NP-9881) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. Progress Report No. 5, October 15, 1960 to January 15, 1961. (Manufacturing Labs., Inc., Cambridge, Mass.). Jan. 15, 1961. Contract AF33(616)-6354. 24p.

Diffusion zone measurements are presented for 10 Mo and Nb-base combinations as well as for several W–, Ta–, and Mo-base combinations reported previously on the basis of preliminary results. Using a criterion that the total diffusion zone should not exceed 50 μ (after annealing 1 hr at 1700°C) and that the hardness increment at the interface should not exceed 500 KHN, the following 12 base-barrier combinations appeared most promising: Os, Ir, Rh, and V barriers on W base metal; W and Zr barriers on Ta base metal; W and Re barriers on Mo base metal; and W, Re, Ta, and Mo barriers on Nb base metal. Consideration will still be given to 9 other combinations (W–Ru, W–Hf, Ta–Re, Ta–Os, Ta–Ir, Mo–Ta, Mo–Ir, Nb–Os, and Nb–Ir), although they appeared somewhat less promising than the first 12 because of either high hardness increments or questionable data. In addition, 6 combinations (Ta–Hf, Mo–V, Nb–Ru, Nb–Hf, Nb–V, and Nb–Zr) are yet to be screened. Longer time diffusion-annealing experiments are being carried out in an attempt to determine the relative potential of the more promising combinations. From the results of these experiments, barrier metals will be selected for studies of interdiffusion characteristics with respect to alloy base metals and for quantitative determination of diffusion characteristics with respect to unalloyed base metals. (auth)

14718 (NP-9916) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 1960. 112p.

A list of DMIC selected accessions for December 1960 is presented. The information is grouped under the headings: light metals, refractory metals, high-strength alloys, miscellaneous metals, and special subjects. Author, subject, and DMIC numerical indexes are included. (M.C.G.)

14719 (NP-9917) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 1961. 43p.

A list of Defense Metals Information Center selected accessions is presented. DMIC numerical, author, and subject indexes are given. The topics covered include light metals, refractory metals, high-strength alloys, miscellaneous metals, and special subjects. (M.C.G.)

14720 (NP-9930) HARD PARTICLE STRENGTHENING OF REFRACTORY METALS FOR HIGH TEMPERATURE USE THROUGH INTERNAL OXIDATION. Progress Report No. 1, January 1, 1961–February 28, 1961. A. S. Bufferd, K. M. Zwilsky, and N. J. Grant (New England Materials Lab., Inc., Medford, Mass.). Mar. 24, 1961. 7p.

A Mo–1.6% Ti ingot containing 0.024% C was converted by machining and dry ball milling to a fine powder. Internally oxidized Mo–1.5% Ti was successfully extruded in a Dynapak and is being evaluated. The alloys were extruded bare with a 20 to 1 reduction coil under an argon cover. Preliminary examinations of the alloys indicated a fine-grained recrystallized structure. (M.C.G.)

14721 (NP-9986) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Bi-Monthly Progress Report, January 2–March 1, 1961. G. E. Spangler and M. Herman (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOw-61-0221-d. 8p. (P-A2476-2)

Two single crystals of beryllium with the basal plane tilted ~20 and 45°, respectively, were subjected to eight zone refining passes which resulted in sufficient curvature to make further melting difficult. A specimen of the 20° crystal underwent, without fracture, a 180° bend about a radius approx equal to its diameter, 0.112 in. A specimen of the 45° crystal was tested to fracture in tension, and exhibited a 156% glide strain on the basal plane, equivalent to 92% elongation. Comparison of the critical resolved

shear stress for basal slip of the 45° crystal, 520 psi, with previously reported values suggests that the observed increase in ductility is the result of a decrease in the impurity concentration. The orientation of a third crystal, tested in tension, was such as to produce the duplex slip on $(10\bar{1}0)$ planes. The resolved shear stress on the basal plane at yielding was ~2000 psi. A 40% over-all elongation was produced with rather severe localized necking to almost a knife-edge fracture. (B.O.G.)

14722 (NRL-5550) PROTECTION OF REFRACTORY METALS FOR HIGH TEMPERATURE SERVICE. THE ZINC-BASE COATING FOR NIOBIUM. Progress Report 1, July 1, 1960. B. F. Brown, R. A. Meussner, R. J. Goode, A. J. Pollard, G. Sandoz, T. C. Lupton, R. L. Newbegin, R. J. Hicks, J. A. Smith, S. W. Strauss, and J. Stoop (Naval Research Lab., Washington, D. C.). Aug. 2, 1960. 33p.

The protective action of a zinc-base coating on niobium is caused by the formation of a tight layer of ZnO. Any breaks occurring in the oxide barrier are self-healed by the formation of additional ZnO resulting from the reaction of air with zinc vapor from zinc-rich intermetallic compounds between the oxide barrier and the niobium. The zinc-niobium phase diagram was determined sufficiently well to place the temperature limitation of the coating at 2048°F, at which temperature the most stable niobium-zinc compound decomposes. Alloy additions have not raised this ceiling while at the same time retaining the self-healing properties. No other metals were found which are as satisfactory as zinc in forming protective coatings for niobium. It appears that zinc is as suitable for niobium alloys as it is for pure niobium, unless these contain high percentages of vanadium. Complex shapes can be vapor coated, but this process does not permit the admixture with the zinc of small amounts of aluminum, titanium, and zirconium, which appear desirable for reliability, particularly at 1800 to 2000°F. An appropriate approach for coatings for 2200 to 2300°F may be to substitute zinc for metal A in compounds A_xNb_y which are stable at the higher temperatures. Another approach may be the use of a cladding metal which would dissolve sufficient zinc at high temperatures to maintain a ZnO barrier. (auth)

14723 (NRL-5581) PROTECTION OF REFRACTORY METALS FOR HIGH TEMPERATURE SERVICE. DURABILITY OF THE ZINC-BASE COATING FOR NIOBIUM. Progress Report 2, October 1, 1960. B. F. Brown, R. A. Meussner, R. J. Goode, G. Sandoz, T. C. Lupton, R. L. Newbegin, J. Stoop, J. A. Smith, S. W. Strauss, and A. J. Pollard (Naval Research Lab., Washington, D. C.). Nov. 16, 1960. 24p.

The effects of the coating thickness, the method and temperature of application of the coating, the composition of the compounds, the temperature of the test, and thermal cycling were examined in life tests lasting approximately 1000 hr. The beneficial effects of titanium and aluminum in the coating were indicated, and the effects of some transition metal additions are reported. Some additional data are presented on the niobium-zinc system. Included are some observations of the redistribution of interstitial impurities in the niobium as a result of the coating and testing procedures and the results of exploratory studies on the oxidation of titanium-zinc and nickel-zinc alloys. (For preceding period see NRL-5550.) (auth)

14724 (ORNL-3076) EFFECT OF ACCELERATION FORCE ON THE SETTLING RATES OF FLOCCULATED THORIA SUSPENSIONS. D. M. Eissenberg (Oak Ridge National Lab., Tenn.). Mar. 29, 1961. Contract W-7405-eng-26. 22p.

The effect of varying the acceleration force imposed on several sedimenting flocculated thoria suspensions was studied. It was found that the Stokes' law prediction of a linear relation between the hindered-settling rate and the acceleration is not valid for the slurries tested, probably from channeling of the escaping water. The settling rate in hindered settling was found usually to be proportional to the 0.65 power of acceleration. Compaction-settling rates were initially independent of acceleration. The rate-controlling factor was probably the vibrations of the centrifuge during operation. It is shown that channeling occurs in the hindered settling of thoria slurries at gravitational acceleration. It is believed that channeling is involved in the deviation from Stokes' law of settling rates at high acceleration. (auth)

14725 (ORO-336) MONTHLY LETTER REPORT NO. 23, PROJECT NO. B-153 COVERING THE PERIOD FROM 15 SEPTEMBER TO 15 OCTOBER 1960. J. D. Fleming. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT-(40-1)-2483. 2p.

Detailed determinations of the elevated temperature tensile strength of slip cast fused silica were begun. An exploratory study was conducted to determine the influence of vibration during casting on the strength of the slip cast fused silica. (W.L.H.)

14726 (SCNC-323) HIGH TEMPERATURE OXIDATION RESISTANT COATINGS FOR TANTALUM BASE ALLOYS. Quarterly Progress Report No. 3, Period Covered December 1, 1960—February 28, 1961. (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). Contract AF33(616)-7462. 55p.

Aluminide and beryllide coatings were applied to the Ta—10% W alloy and a Nb alloy sheet and evaluated at temperatures of 2500°F and higher by a number of oxidation methods. The aluminide coatings were applied by hot dipping, pack calorizing, and slurry painting or spraying. Various coating thickness of the beryllides were applied by vapor-solid reactions. The pure aluminides and beryllides gave good isothermal oxidation protection but thermal cycling caused more rapid failure. Adding tin to the aluminum coatings greatly improves cyclic oxidation resistance. A sprayed 50% Sn—50% Al coating will withstand cyclic oxidation for ten hours or more in the temperature range of 2500° to 3000°F. (auth)

14727 (TG-370-14) RAMJET TECHNOLOGY—MATERIALS FOR RAMJET ENGINES AND COMPONENTS. C. W. Besserer (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Dec. 1958. 59p.

Problems in the selection of materials for ramjet applications are discussed. The engine was considered to be made up of combustion-system components and diffuser-system components. This breakdown by function gave two different temperature zones for design Mach numbers. It is indicated that the nature of the materials problem is a function of temperature and time in a measure beyond the requirements of more conventional applications. Ways in which the mechanical and physical properties of materials are affected by temperature and load as a function of time were considered. Yield stress, tensile strength, weight-strength ratio, elasticity, thermal expansion, thermal conductivity, and elongation were among the properties investigated. The materials studied include steels, Hastelloy X, Inconel X, cermets, refractory metals, aluminum alloys, magnesium, titanium and its alloys, and molybdenum. (M.C.G.)

14728 (TID-11106) STUDY OF FACTORS INFLUENCING DUCTILITY OF IRON—ALUMINUM ALLOYS. Monthly

Letter Report. (Denver. Univ. Denver Research Inst.). Nov. 9, 1960. Contract AT(11-1)-742.

The objective of the program is to determine the effect of variations of aluminum content, heat treatment, surface preparation, and other metallurgical factors upon the room-temperature ductility of Fe–Al alloys. As a continuation of the metallographic deformation studies, two coarse-grained tensile specimens of 13.9-Alfenol were heat treated, electropolished, and pulled to fracture. (W.L.H.)

14729 (TID-11336) A PRELIMINARY REPORT OF THE PROPERTIES OF WELDMENTS IN TYPE 305 STAINLESS STEEL. Technical Memo. No. 48. J. File (Princeton Univ., N. J. Project Matterhorn). Aug. 6, 1957. 19p.

The properties of weldments in type 305 stainless steel using E-308 and E-310 welding rods were investigated. Methods of heat treatment of stainless steel so that dimensional stability could be maintained after the material was welded or rough machined were studied. Several samples of type 305 stainless steel were welded using the two types of welding rods and the samples were subjected to at least two kinds of heat treatment. Two series of tensile tests were run. It was found that all the samples welded by type E-308-16 rods did not have full penetration of the weld material. As a result all the failures occurred in the weld at an average stress of about 80,000 psi. It was found in the second series of tests that the ductility varied over a range of about 10%. The yield point for all the welds was at approximately 45,000 psi. The magnetic permeabilities of the welds were also measured. In all cases where full penetration of the weld was accomplished, the weld was stronger than the parent material. The type E-308-16 rod yielded magnetic welds and type E-310-16 rods yielded essentially non-magnetic welds. There was some evidence that heat treatment of the magnetic welds tended to reduce the magnetic permeability and the high-temperature heat treatment seemed to have more effect than the low-temperature heat treatment. (M.C.G.)

14730 (TID-11894) TYPE 316 STAINLESS STEEL MATERIAL PROPERTIES SUMMARY. James Nassau (Pratt and Whitney Aircraft Div., United Aircraft Corp., [Hartford, Conn.]). Nov. 1, 1957. 41p. (FXM-3140)

A summary is presented of the properties of type-316 stainless steel determined at 1200 to 1800°F in air and sodium. The properties are short time yield, ultimate tensile strength, stress-rupture and total creep strengths (in air and sodium), modulus of elasticity, and coefficient of expansion. A comparison is made of tube bursts with uniaxial rupture strength at 1350, 1570, and 1650°F; the agreement is good. (D.L.C.)

14731 (TID-11931) CRYSTALLIZATION OF THE PEROVSKITE LEAD TITANATE FROM GLASSES. Report for the Initial Period June 1960–January 1961. C. G. Bergeron and A. L. Friedberg (Illinois. Univ., Urbana). Feb. 15, 1961. Contract AT(11-1)-915. 56p.

A study was made of ferroelectric lead titanate crystals precipitated from glasses. Work in formulating a glass system suitable for nucleation and growth studies was undertaken. Some quantitative x-ray analysis of crystallized lead titanate in glass are reported along with crystal growth observation at high temperatures, and DTA experiments. The results indicate that (1) an endothermic reaction on DTA runs may be associated with the nucleation phenomenon, (2) growth behavior of lead titanate indicated columnar or acicular crystals in silicate glasses and equant isometric crystals in borate glasses, and (3) surface crystallization occurred on the surface of interior bubbles in the glass. (auth)

14732 (TID-12107) INVESTIGATION OF THERMODYNAMIC ACTIVITIES AND SOLUBILITY RELATIONSHIPS IN BISMUTH SYSTEMS. Progress Report, February 1960 to February 1961. (Michigan. Univ., Ann Arbor). Contract AT(11-1)-543. 4p.

A discussion is given of work done to find a relation between optical absorption and concentration of metallic atoms in the vapor state for bismuth from Bi-U alloys and cadmium from Cd-Ag alloys. Third component interactions, for cerium, copper, lead, nickel, palladium, and rhodium, with uranium in liquid bismuth solutions were studied using the equilibrium occurring along the liquidus ($\underline{U} + 2Bi \rightarrow UBi_2$) and the equilibrium decomposition of UC_2 in a bismuth solvent ($UC_2 \rightarrow \underline{U} + 2C$) at 400 to 800°C. (B.O.G.)

14733 (TID-12129) HIGH TEMPERATURE FERROELECTRIC MATERIALS. PIEZOELECTRIC PROPERTIES OF LEAD METANIOBATE. Final Report covering Period November 1, 1957 to December 31, 1960. J. P. Dietz, A. V. Illyn, V. L. Popoff, and W. Tantraporn (General Electric Co. Missile and Space Vehicle Dept., Philadelphia and General Electric Co. Electronics Lab., Syracuse, N. Y.). For Sandia Corp. Purchase Order 14-4796. 90p. (SCDC-2268).

The phase relationships in the $PbO–Nb_2O_5$ system were studied under both equilibrium and nonequilibrium conditions. As a result, it was possible to define compositional limits whereby the yields of the ferroelectric phase (Goodmanite) are considerably increased. It was found that a solid solution region exists in the composition region extending from about 50 to 52 mol % Nb_2O_5. Previously, the preparation of Goodmanite was sometimes complicated by the presence of a stable nonferroelectric phase (Francombite) when the starting materials were made up stoichiometrically. Further, under these conditions the yield of metastable Goodmanite depended critically on the firing temperature and cooling rate. It was possible to completely depress the Francombite content by restricting the composition to the area defined by the limits of solid solution, and the tolerances involved in the processing variables, such as firing temperature and cooling rate, were much less rigid. The "state of the art" with regard to the fabrication of large specimens was improved as a result of the phase studies; and larger items can now be made with more confidence. The electrical, mechanical, and piezoelectric properties of a number of compositions were measured and these results are discussed in relation to the phase studies. It was found that these properties vary as the distribution of phases in the material. The dielectric constant and loss increased with increasing Goodmanite content while the ceramic and mechanical properties were considerably improved. The piezoelectric response remained anomalous in that large increases in the concentration of the ferroelectric phase were not reflected by significant increases in d_{33}. (auth)

14734 (TID-12137) EFFECT OF DIISOCYANATE STRUCTURE ON LOAD-BEARING PROPERTIES OF FLEXIBLE URETHANE FOAMS. Carl A. Peterson and Clifford H. Smith (Bendix Corp., Kansas City, Mo.). [1960]. Contract [AT(29-1)-613]. 53p.

Flexible urethane foams can be shaped, contoured, or molded to size to meet specific application requirements. Additional properties of the flexible urethane foams that make them useful in cushioning applications include: good tear strength, low temperature flexibility, low flexing fatigue, and good tensile and elongation properties. The effect of various diisocyanates upon the properties of these foams was investigated. It was previously pointed out that the physical properties of urethane elastomers are af-

fected by the molecular structure of the diisocyanate used in their preparation. By analogy, it would be expected that this relationship should also apply in urethane foams. In this investigation, it was demonstrated that different diisocyanates do influence the physical properties of flexible urethane foams. The load-bearing properties of these foams are shown to be significantly influenced by the various diisocyanates or combinations of diisocyanates used in the preparation of the isocyanate prepolymers. The flexible urethane foams considered in this study are based on polyether prepolymers. Eight commercially available diisocyanates were investigated. The synthesis of the isocyanate terminated polyether prepolymers, and their use in formulating foamed materials are discussed. Particular emphasis is placed on the study of the relationship between diisocyanate configuration and load-bearing properties of the finished foams. (auth)

14735 (TID-12307) MAGNETIC SUSCEPTIBILITY OF MATERIALS COMMONLY USED IN THE CONSTRUCTION OF CRYOGENIC APPARATUS. G. L. Salinger and J. C. Wheatley (Illinois. Univ., Urbana). [nd]. Contract AT(11-1)-67. 12p.

Magnetic susceptibility measurements were made for some weakly magnetic materials at 1.6 to 4.2°K. The results are tabulated for dielectric structural materials, fibrous materials, fluids, metals, sheets, tapes, and special materials. The mechanical properties of several of the materials are given. (B.O.G.)

14736 (TID-12308) SPECIFIC HEAT AND THERMAL BOUNDARY RESISTANCE OF LIQUID He^3. A. C. Anderson, G. L. Salinger, W. A. Steyert, and J. C. Wheatley (Illinois. Univ., Urbana). [1960?]. Contract AT(11-1)-67. 12p.

Heat capacity measurements were made for cerium magnesium nitrate and liquid He^3 at 14 cm-Hg and 0.008 to 0.040°K. The heat capacity of He^3 was found to be linear in T within experimental scatter. The ratio of the effective mass of quasi-particles to the mass of the He^3 atom was derived to be 2.35 ± 0.20. The heat transfer rate across the interface between liquid He^3 and its container was found proportional to the differences in the fourth powers of the temperatures. (B.O.G.)

14737 (TID-12311) THE KINETICS OF TRANSFORMATION OF NIOBIUM-BASE, ZIRCONIUM ALLOYS. Monthly Letter Report No. 10, February 1, 1961 to March 1, 1961. Charles E. Lundin (Denver. Univ. Denver Research Inst.). Mar. 13, 1961. Contract AT(11-1)-752, Supplement No. 3. 6p.

The preparation of Nb-base Zr resistivity test specimens using a combination of hot and cold swaging was studied. A total of six ingots was prepared, and chemical analysis and hardness data for the tops and bottoms of the ingots are presented. Photomicrographs are also presented which indicate that the 10 and 14 wt.% Zr alloys have single-phase beta Nb microstructures and the 17, 18, and 21 wt.% Zr alloys have small amounts of second-phase beta Zr at the grain boundaries in addition to the fine particles which are believed to be ZrO_2. (D.L.C.)

14738 (TID-12312) PROPERTIES OF MATERIALS AT LOW TEMPERATURES. Progress Report. John C. Wheatley (Illinois. Univ., Urbana). Mar. 1961. Contract AT(11-1)-67. 41p.

The magnetic susceptibility of some weakly magnetic materials was measured in the 1.6 to 4.2°K temperature range. Most of the materials tested are generally considered to be non-magnetic. The classes of materials investigated were dielectric structural materials, fibrous materials, fluids, metals, sheets and tapes, and special materials. Uses are listed for the materials. The heat capacity of a mixture of powdered cerium magnesium nitrate (CMN) and liquid He^3 was measured at pressures near 14 cm Hg and at temperatures extending from 0.008 to 0.040°K. When the heat capacity of the CMN was subtracted, the resultant heat capacity was found to be linear in temperature within experimental scatter. A value of 2.35 ± 0.20 was derived for the ratio of the effective mass of the quasi-particles to the mass of the He^3 atom. The rate of transfer of heat across the interface between the liquid He^3 and its container was measured and found to be proportional to the differences in the fourth powers of the temperature as expected from the picture of the exchange of phonons between two reservoirs at different temperatures. The transfer of electrically-supplied heat from a copper thermal link into single-crystal slabs of chromium potassium alum was measured in the temperature range from 0.03 to 0.15°K. Temperature differences produced by heating were less than 6% of the average temperature. Comparison with other experiments led to the conclusion that heat flow rates into single crystals of ferric and chrome alum are proportional to the contact area with the thermal link and are reproducible. Results suggested that the T^3 thermal conductance is a boundary effect and that the phonon mean free path within the chrome alum crystals is sufficiently long to insure that the crystal temperature is homogeneous. (M.C.G.)

14739 (WADC-TR-58-452(Pt.III)) METAL FIBER REINFORCED CERAMICS. J. R. Tinklepaugh, B. R. Goss, W. R. Hoskyns, J. H. Connor, and D. D. Button (New York. State Univ. Coll. of Ceramics, Alfred). Oct. 3, 1960. Contract AF33(616)-5898. Project No. 7350. 89p.

The flexural properties of a ceramic-metal fiber system were studied. It was found that the metal fiber assumes a part of the load which is to some degree in proportion to the relative elasticity moduli of the ceramic and metal. The test data for the alumina-molybdenum and alumina-mullite-molybdenum systems were extended to 3000°F. Hafnium oxide was found to have desirable characteristics for use in a composite system. (auth)

14740 (WADC-TR-58-476(Vol. II)(Rev.)) THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS. VOLUME II: ALLOYS (MELTING TEMPERATURE ABOVE 1000°F). Revised Edition. Alexander Goldsmith, Harry J. Hirschhorn, and Thomas E. Waterman (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 30, 1960. Contract AF33(616)-5212. 608p.

Thermophysical property data, and their variation with temperature are presented for alloys melting above 1000°F, based on literature published during the period 1940 through 1957. Properties covered include melting point, density, latent heats, specific heat, thermal conductivity, thermal diffusivity, emissivity, reflectivity, thermal expansion, vapor pressure, and electric resistivity. Fe, Cu, Ni, Co, Al, Mg, Ti, Be, Au, Ag, Pt, Pd, Mn, V, Si, and refractory metal alloys were investigated. (M.C.G.)

14741 (WADD-TR-60-240) RESEARCH ON PROPERTIES OF HIGH STRENGTH MATERIALS SUITABLE FOR HIGH TEMPERATURE APPLICATIONS. Harold N. Cummings, Foster B. Stulen, and William C. Schulte (Curtiss-Wright Corp. Propeller Div., Caldwell, N. J.). May 31, 1960. Contract AF33(616)-6552. 54p. (AD-243901).

Investigations of the fatigue behavior of high-strength alloys were continued. Bars of iron–molybdenum alloys, intended for study as to suitability for ball bearings at temperatures up to 1000°F were found to be so non-homogeneous and brittle that specimens could not be machined from them. High-temperature torsion tests of relaxation

were made to study the suitability of two alloys, M-1 tool steel and Inconel X, for springs at 1000°F, and of two alloys, Waspalloy and Udimet 500, for springs at 1500°F. Alternating torsion of ±10 ksi, superimposed on an initial steady stress of 25 ksi, was applied to specimens of each alloy. Inconel X lost about 10 to 15% of the steady load in about 100 hr. The other three alloys relaxed two or three times as much. (auth)

14742 (WADD-TR-60-525) ELEVATED TEMPERATURE CREEP PROPERTIES OF B12OVCA SHEET MATERIAL. Period Covered July 1959–January 1960. Edward L. Horne and William D. Harden, III (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). May 4, 1960. 40p.

An investigation was made to determine creep properties at elevated temperatures of aged B12OVCA titanium alloy to aid in the evaluation of this alloy. Tests were conducted at 600, 650, and 700°F on sheet specimens cut both perpendicular and parallel to the direction of rolling. Differences in properties with respect to direction of rolling were small. Data include ultimate tensile strength, tensile yield strength, and creep rupture properties at each temperature. Ultimate tensile strengths varied from 187,700 psi at 750°F to 166,000 psi at 700°F. Creep deformation became more rapid at higher temperatures, indicating that 700°F is close to the long-time temperature limit of this alloy. There was marked scatter of the creep properties of the alloy at 600°F but the average strength properties were good. (auth)

14743 (WADD-TR-60-581) THERMAL PROPERTIES OF REFRACTORY MATERIALS. Guy W. Lehman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 1960. 19p. Contract AF33 (616)-6794.

A pulse heating method for measuring the specific heat of conductors from near absolute zero to their melting point is described. Results obtained on copper, iron, molybdenum, tantalum, and rhenium are reported. They indicate that the pulsed heating method gives specific heat data accurate to a few percent. The measurements show that the heat capacities of molybdenum and tantalum gradually rise above their Dulong and Petit values of 0.06253 and 0.03316 cal/gm/°C, respectively, at high temperatures. At 2800°K, c_p (Mo) = 0.1350 cal/gm/°C and at 3200°K, c_p (Ta) = 0.0667 cal/gm/°C. These anomalies were noted in other transition metals. The percentage elongation, relative to room temperature, of zirconium carbide was measured between 1000 and 2000°C and was found to vary linearly from 0.6% at 1000°C to 1.6% at 2300°C with a permanent set occurring above 2300°C. A transient method for measuring thermal diffusivity, specific heat, and thermal conductivity of insulators as well as conductors is under development for the temperature range 20°C to 2500°C. (auth)

14744 (WAL-TR-310/219) EFFECT OF CERIUM ON 500°F EMBRITTLEMENT IN 9840 STEEL. Joseph M. Dhosi (Watertown Arsenal Labs., Mass.). Feb. 1961. 21p. (PB-171473).

Split heats of 9840 steel, containing various amounts of cerium, from 0 to 0.28%, were melted. The steels, in both cast and wrought conditions, were quenched and tempered and tested in impact. It was found that cerium, in the presence of low residual amounts of nitrogen and sulfur, has a detrimental effect on the impact energy of this steel. (auth)

14745 (WAL-TR-811.2/1) THE TEMPERATURE COMPENSATED DEBYE TEMPERATURE OF ANNEALED IRON POWDERS. Charles P. Gazzara and Raymond M. Middleton (Watertown Arsenal Labs., Mass.). Feb. 1961. 11p. (PB-171500)

The Debye-temperature-dependent explicit temperature function τ was found to be 4.1 for annealed carbonyl iron from x-ray diffraction intensity measurements by assuming the static atomic displacement vector to be zero. The corresponding Debye temperature, corrected for temperature diffuse scattering, was calculated to be 435°K at temperature 310°K. (auth)

14746 (WAPD-ZH-27(p.12-14)) THE EFFECT OF HYDROGEN CONTENT ON CHARPY IMPACT STRENGTH OF ZIRCALOY-2 AND ZIRCALOY-4. J. D. Grozier (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Standard "V" notched Charpy impact specimens were machined from Zircaloy-2 ingot OM 303 and Zircaloy-4 HZC 685 which were mixed with varying amounts of ZrH powder, fractured, and tested for hydrogen using sections cut from the specimens at the fractures. Increasing hydrogen content was found to decrease the Charpy impact strength for both alloys. The data were fitted to the equation $\log_{10}(\text{C.I.S.}) = a + b \log_{10}(\text{H.C.})$, where (C.I.S.) is the Charpy impact strength in ft-lb and (H.C.) is the hydrogen content in ppm. For Zircaloy-2, the equation is $\log_{10}(\text{C.I.S.}) = 1.65833 - 0.51797 \log_{10}(\text{H.C.})$, while for Zircaloy-4 it is $\log_{10}(\text{C.I.S.}) = 2.09740 - 0.70775 \log_{10}(\text{H.C.})$. (D.L.C.)

14747 (AEC-tr-4052(p.241-58)) FUSION DIAGRAM FOR THE QUATERNARY SYSTEM $Li_2Cl_2-Na_2Cl_2-K_2Cl_2-Li_2SO_4$. E. K. Akopov and A. G. Bergman. Translated from Zhur. Neorg. Khim., 2: No. 2, 383-94(1957).

The quarternary reciprocal system Li, Na, K || Cl, SO_4 was studied. The phase diagram of the system can be represented in the form of a prism. The stable section $Na_2Cl_2-K_2Cl_2-Li_2SO_4$ divides the prism into the stable tetrahedron $Li_2Cl_2-Na_2Cl_2-K_2Cl_2-LiSO_4$ and the pentagon $Na_2Cl_2-K_2Cl_2-Li_2SO_4-Na_2SO_4-K_2SO_4$. The stable tetrahedron, representing an independent quaternary system, was investigated by the fusibility method. The binary and ternary systems within the quaternary system were studied. The formation of the compound LiCl · NaCl, melting with decomposition at 575°C, was established. The solid solutions of NaCl · KCl within the system decomposed into their components. It was established that the medium affects the stability of such solid solutions. In the presence of LiCl the decomposition temperature was decreased and in the presence of Li_2SO_4 it was somewhat increased. (M.C.G.)

14748 (AEC-tr-4054(p.233-45)) ON THE PHASE DIAGRAM OF THE TERNARY SYSTEM Ni–Cr–W. I. I. Kornilov and P. B. Budberg. Translated from Zhur. Neorg. Khim., 2: No. 4, 860-7(1957).

The phase diagram of the Ni–Cr–W system was investigated to determine the possibility of the production of ternary nickel solid solutions with a considerable concentration of chromium and nickel. To ascertain the polythermal extent of the expansion of the limited nickel solid solution as well as of the adjacent phases of the ternary system, alloys with a content of 50% chromium and 30% tungsten were examined. The microstructure of the alloys was examined after they were subjected to various thermal treatments. The modification of the parameter of the crystal lattice of a solid solution of nickel in relation to its content of chromium and tungsten was determined by x-ray analysis of the alloys. (M.C.G.)

14749 (AEC-tr-4054(p.368-77)) MEASUREMENT OF THE VAPOR PRESSURES OF SODIUM AND RUBIDIUM CHLORIDES AND THEIR BINARY MIXTURES BY THE

RADIOACTIVE INDICATOR METHOD. An. N. Nesmeyanov and L. A. Sazonov. Translated from Zhur. Neorg. Khim., 2: No. 4, 946-51(1957).

Vapor pressures of sodium and rubidium chlorides and their systems were measured by the Knudsen effusion method using the radioisotopes Na^{24} and Rb^{86}. The radiochemical purity of the preparations was carried out by measuring the half-life period of both the initial substances and the condensate obtained on vaporization. Partial pressures of saturated vapors of sodium chloride and rubidium chloride in the binary mixture are given. It was found that the components of the system possess no noticeable solubility in the temperature interval of 773 to 891°K. The results obtained for temperatures below 773°K were inconclusive. (M.C.G.)

14750 (AEC-tr-4056(p.288-304)) MODEL SYSTEMS OF $Na_2BeF_4-LiBeF_4$ AND $Ca_2SiO_4-Mg_2SiO_4$. N. A. Toropov and I. L. Sochetnikova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1392-1400(1957).

A study was made of the system $Na_2BeF_4-Li_2BeF_4$, as an analog of the orthosilicate system $Ca_2SiO_4-Mg_2SiO_4$. As a result of thermographic and x-ray studies of Na_2BeF_4, it was established that the ortho-beryllate of sodium has four polymorphic forms. Three of the forms are stable and one, β-Na_2BeF_4, is metastable. The polymorphic form γ^1-Na_2BeF_4, the existence of which was indicated by Thilo, at a temperature of 187°C, was not observed either on the crystals obtained from the solution or on crystals obtained from the melt. The results obtained confirmed the analogy of Na_2BeF_4 with the orthosilicate of calcium. The study of the fluo-beryllate of lithium, Li_2BeF_4, showed that Li_2BeF_4 melts congruently at a temperature of 470° and exists in one polymorphic form similar to Mg_2SiO_4. (M.C.G.)

14751 (AEC-tr-4056(p.315-20)) THE PHASE DIAGRAM OF THE TERNARY SYSTEM OF LITHIUM, CALCIUM AND BARIUM FLUORIDES. G. A. Bukhalova and V. T. Berezhnaya. Translated from Zhur. Neorg. Khim., 2: No. 6, 1408-12(1957).

An investigation was made of the ternary system formed by lithium, calcium, and barium fluorides. The study was carried out by the visual-polythermic method in a platinum crucible provided with a platinum stirrer. The three binary systems within the ternary system were studied. The surface of crystallization of the ternary system was found to consist of 4 fields of crystallization, converging on two triple nonvariant points. A sudden sharp drop in the melting point of the fusion of the high temperature components CaF_2 and BaF_2 was noted as a result of the introduction of lithium fluoride. This alloy is therefore recommended for welding nonferrous metals. (M.C.G.)

14752 (AEC-tr-4056(p.342-8)) THE $RbF-BeF_2-H_2O$ SYSTEM AT 25°C. N. S. Tamm and A. V. Novoselova. Translated from Zhur. Neorg. Khim., 2: No. 6, 1428-31 (1957).

The solubility isotherm at 25°C of the $RbF-BeF_2-H_2O$ system was studied. The study established the existence of two more double salts, $RbBeF_4$ and $RbBe_2F_5$, in addition to Rb_2BeF_4. Both of these salts were incongruently soluble in water and crystallized from solutions containing an excess of beryllium fluoride in relation to rubidium fluoride. The solution and solid phases were analyzed for rubidium by the chloroplatinate method and for beryllium by the iodometric method. (M.C.G.)

14753 (AEC-tr-4058(p.222-33)) PHASES FORMED IN THE CHROMIUM–BORON SYSTEM. V. A. Epel'baum, N. G. Sevast'yanov, M. A. Gurevich, B. F. Ormont, and G. S. Zhdanov. Translated from Zhur. Neorg. Khim., 2: No. 8, 1848-54(1957).

Results are given of the investigation of a series of preparations in the chromium–boron system. Initial compositions ranged from $CrB_{0.01}$ to $CrB_{0.375}$, and samples of metallic chromium which were subjected to heat treatment at various temperatures and for various time periods were also studied. The initial and final preparations were examined by x-ray phase analysis using chromium radiation. Data showed that at small additions of boron, along with α-chromium which has a body-centered lattice, the so-called β-modification of chromium "β-Cr" having a hexagonal lattice is formed. It was found that at room temperature the β-Cr is due to the solution of impurities in chromium. It was established that the solution of boron in α-Cr takes place, but apparently in small quantities. (M.C.G.)

14754 (AEC-tr-4058(p.285-93)) FUSION DIAGRAM IN THE SYSTEM OF THE NITRATES AND CHLORIDES OF BARIUM AND CALCIUM. A. G. Bergman and M. B. Tokareva. Translated from Zhur. Neorg. Khim., 2: No. 8, 1888-94(1957).

The system Ca, Ba || Cl, NO_3 was investigated by the visual-polythermal method in a refractory glass test tube. Because of the relatively high melting points of all the initial components and the thermal instability of the nitrates, not all the regions of the system could be investigated. The system was found to be irreversible and reciprocal, having a continuous series of solid solutions of nitrates of barium and calcium and compounds of their chlorides in the ratio 1 : 1. Eleven internal sections were examined in order to determine the configuration of the system. Sharp inflections were found in the range 330 to 338 degrees on the branches of $Ba(NO_3)_2$, apparently corresponding to homeomorphic α/β transformations of $Ba(NO_3)_2$. (M.C.G.)

14755 (AEC-tr-4058(p.294-310)) THE FUSION DIAGRAM OF THE SYSTEM OF POTASSIUM AND STRONTIUM NITRATES AND CHLORIDES. M. V. Tokareva and A. G. Bergman. Translated from Zhur. Neorg. Khim., 2: No. 8, 1895-6(1957).

Data are presented on the ternary reciprocal systems of chlorides and nitrates of potassium and strontium which are characterized by marked complex formation on the lateral sides of the system and within its interior. Most of the investigation was carried out by means of the visual-polythermal melting method in refractory glass test tubes fitted with external glass jackets. The binary chloride system $K_2Cl_2-SrCl_2$ and some of its cross sections located in the highest melting region of the system were examined in a platinum crucible heated in a shaft furnace. Twenty-five internal sections of the reciprocal system were examined and their position in projection onto the composition square is shown. A comparison with the K, Ba || Cl, NO_3 and Na, Sr || Cl, NO_3 systems revealed a higher degree of irreversibility and a stronger tendency to complex formation. (M.C.G.)

14756 (AEC-tr-4418) ALLOYS OF THE PLATINUM METALS WITH TUNGSTEN. Ernest Raub and Paul Walter. Translated from Heraeus Festschr., 1951, 124-46. 24p.

The alloys of platinum metals with tungsten were examined in melted samples by x-ray analysis, microscopic studies, and hardness measurements. In the solid state, the platinum metals were all found to be capable of dissolving tungsten. The solubility was the greatest in ruthenium and osmium. In the cubic plane-centered platinum

metals, the solubility of tungsten was substantially lower. The ruthenium–tungsten and palladium–tungsten alloys did not show any intermediate phase. In the osmium–tungsten system, an intermediate crystal type with a narrow area of homogeneity was observed. This crystal was assumed to be the compound Osn_3. In the rhodium–tungsten and iridium–tungsten systems, an intermediate phase with hexagonal close-packing appeared which had a larger area of homogeneity in both systems. The hardness of some of the alloys was very high. Osn_3 and the hexagonal intermediate phase of the iridium–tungsten alloys were exceptionally hard. The hardness of the corresponding phase of the rhodium–tungsten system remained lower. (auth)

14757 (AEC-tr-4521) THE STRUCTURE OF GALVANIC ALLOY DEPOSITS. IV. SILVER–CADMIUM ALLOYS. Ernst Raub and Bernhard Wullhorst. Translated for Oak Ridge National Lab. from Z. Metallk. 38: 33-41(1947). 34p. (Includes Original, 9p.).

Galvanic cadmium-silver alloy deposits are easily prepared from solutions of the double cyanides of the metals which still contain a certain excess of free cyanide. Structure and characteristics of cadmium-silver deposits from the baths are particularly dependent on the deposition conditions. The composition of the deposits is extensively influenced by aging processes. The solubility of cadmium in silver in the case of galvanic cadmium-silver alloy deposits is dependent on the composition of the baths, and the polarization determined by it during the deposition. An extensive solid-solution formation occurs only when the polarization of the silver deposition is raised to that of cadmium and beyond it by suitable additions. The α-cadmium-silver solid solution is deposited at nobler potential values from the baths than the individual metals. The β^-, γ^-, and ϵ-phases, in addition to the α-phase, were determined in alloys with up to 85% Cd in a composition corresponding to that of thermally prepared alloys. The β-phase is found in galvanic cadmium-silver alloys in a form which is metastable at room temperature. (auth)

14758 (AEC-tr-4522) GROWTH OF ALPHA-URANIUM AS THE RESULT OF CORRELATIVE COLLISIONS. Ulrich Gonser. Translated from J. Nuclear Materials, 2: 43-50 (1960). 10p.

The correlated collision model was found to be suitable for interpreting the irradiation-induced growth of α-U and the phenomena associated with the growth. In the neighborhood of a fission spike the following processes were found to occur preferentially in the three principal crystallographic directions: [100], focusons; [010], dynamic crowdions; and [001], high density of Frenkel pairs. The transition from anisotropic growth to isotropic swelling under irradiation, as observed at high temperatures, was found to be a consequence of the defocusing of the correlated collisions. The variation of irradiation-induced growth with grain size and the possibility of reducing it are discussed. The existing spike and diffusion models of growth are outlined. (auth)

14759 (AEC-tr-4534) METALLOGRAPHY–STUDY OF THE SELF-DIFFUSION OF ZIRCONIUM IN THE BCC β PHASE. Dimitri Volokoff, Serge May, and Yves Adda. Translated from Compt. rend., 251: 2341-3(Nov. 21, 1960). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 9452.

14760 (NP-tr-586) A STUDY OF THE DISSOCIATION OF A SUPERSATURATED NICKEL–CHROMIUM–TITANIUM–ALUMINUM SOLID SOLUTION. V. G. Chornii (Chorniy). Translated from Dopovidi Akad. Nauk Ukr. R.S.R., No. 4, 362-6(1957). 10p.

The changes in the fine crystal structure due to the dissociation of a heat-resistant Ni–Cr–Ti–Al alloy were investigated. The study was carried out with specimens hardened at 1080°C and quenched in water and with specimens deformed by 80% after the hardening. The state of the intermetallic phase was studied radiographically on powders obtained by electrolysis. The magnitudes of the strains, the coherent scattering regions, and the lattice parameters were determined. The investigation showed that in all cases of dissociation, both of the hardened and deformed alloy, only an intermetallic phase with the face-centered cubic lattice is formed. The main factor responsible for the increased hardness of the alloy after the lattice was heated in the 700 to 750°C temperature range was the formation of large amounts of a finely dispersed second phase. It was concluded that the increase in the strength of a hardened alloy upon deformation is due to the development of submicroscopic irregularities in the structure of the solid solution and possibly to the formation of an intermetallic phase. (M.C.G.)

14761 (NP-tr-588) INVESTIGATION INTO RECRYSTALIZATION OF NIOBIUM AND ITS ALLOYS. E. (Ye.) M. Savitskii (Savitskiy), V. V. Baron, and K. N. Ivanova. Translated from Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 1: No. 11, 38-45(1958). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 18151. 18151.

14762 (UCRL-Trans-647(L)) FORMATION TIME OF THE MARTENSITE CRYSTAL. V. N. Arskii. Translated from Metalloved. i Obrabotka Metal., No. 11, 26-9(1956). 12p. (Includes original, 4p.).

Measurements of the rate of growth of martensite crystals in steel are discussed. The methods used by various scientists in their measurements are described. On the basis of several studies, some conclusions were drawn. The average growth rate of the martensite crystals, determined as a ratio of the diameter of the martensitic lamina to the time of its formation, was found to be equal to 10^6 mm/sec. The average growth rate did not depend on temperature. The formation time depended on size and was approximately equal to 10^{-7} sec. The shape of the signal during isothermal transformation was the same as in the case of transformation during cooling. The formation consisted of two processes, the appearance of a two-dimensional nucleus and the increasing of its thickness. The thickness of the martensite lamina did not increase uninterruptedly, but did it in the course of several consecutive stages with definite time intervals. (M.C.G.)

14763 MELTING POINTS AND OTHER PARAMETERS OF THE LOWER OXIDES OF NIOBIUM. O. P. Kolchin and N. V. Sumarokova. Atomnaya Energ., 10: 168-70(Feb. 1961). (In Russian)

The melting point, microstructure, electric conductivity, and oxidation of lower oxides of niobium were studied with prepared specimens containing 0.04 to 0.06 wt.% C and 0.03 wt.% N and composition of $NbO_{0.95}$, $NbO_{1.01}$, and $NbO_{1.02}$ in a homogeneous niobium oxide. The melting point for niobium monoxide was found at 1935°C and for niobium dioxide at 2080°C. Evaporation of niobium monoxide and dioxide begins at 1700°C. All monoxides evaporated after 4 hours at 1850°C, and 45 wt.% of dioxide evaporated. After 8 hours all dioxide evaporated. Microhardness of niobium monoxide within homogeneous oxide limits is 1930 kg/mm^2; the eu-

tectic microhardness is 794 kg/mm^2 at 50 g load. The microhardness of niobium dioxide is 1720 kg/mm^2; however, the latter is not accurate as cracks were observed later. The niobium monoxide exhibits metal-type electric conductivity, while niobium dioxide is a semiconductor. After 6 hours heating at 100, 150, 200, 225, 250, and 275°C, the content of oxygen was not changed, while in niobium dioxide it slightly increased at 275°C, and at 150°C the surface of the monoxide and dioxide dust particles became yellow. At 200°C they acquired a bronze color. After 6 hours at 300°C both the monoxide and dioxide of niobium oxidized into niobium pentoxide. (R.V.J.)

14764 HIGH-TEMPERATURE HARDNESS OF SOME ALLOYS BASED ON NIOBIUM. I. I. Kornilov and R. S. Polyakova. Atomnaya Energ., 10: 170-2(Feb. 1961). (In Russian)

The temperature dependence of hardness of pure niobium and its alloys was studied at room temperature and from 100 to 1000°C the hardness curve for pure niobium (13.8 kg/mm^2 at 20°C) drops smoothly up to 400 to 600°C, after which it drops sharply down to 10 kg/mm^2 at 1000°C. The strengthening coefficients of alloying materials (molybdenum, zirconium, silicon, aluminum, etc.) plotted for 20, 800, and 1000°C show for two-component alloys strengthening of 1.5 at room temperature, 5.0 at 800°C, and 10.8 at 1000°C; for six-component alloys the strengthening was 2.96 at 20°C and 19.3 at 1000°C. (R.V.J.)

14765 THE STRENGTH OF CERAMIC MATERIALS. Winston H. Duckworth and Alfred Rudnick (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev., 10: No. 4, 3-8(Apr. 1961).

The fracture theory is used in explaining the strength of ceramic materials. Such effects of factors such as porosity; crystal diameter, shape, and size; and load also are discussed. (N.W.R.)

14766 AN INVESTIGATION OF THE EQUILIBRIUM OF PHASES IN THE Ti_3Sn-Zr SYSTEM. V. V. Glazova and N. N. Kurnakov (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 100-3(Jan. 1, 1961). (In Russian)

Theoretical studies were made of phase equilibrium in the system Ti–Zr–Sn. Microscopic and thermal analyses and hardness measurements indicate that Ti_3Sn-Zr is a quasi-binary system. It was also shown that there exists a continuous series of solid solutions between the low-temperature modification and the intermetallic compounds of zirconium and Ti_3Sn. Phase transformations in Ti_3Sn–Zr alloys are tabulated according to temperatures, and a triangulation of the triple system is plotted. (R.V.J.)

14767 THE DIFFUSION OF BORON IN CARBON. P. S. Kislii and G. V. Samsonov (Inst. of Powder Metallurgy and Special Alloys, Academy of Sciences, Ukrainian SSR). Fiz. Tverdogo Tela, 2: 1729-32(1960).

Preliminary experiments are performed on the diffusion of boron in graphite and investigations of the properties of the boron carbide obtained in this way. It is found that by the diffusion of boron in graphite alloys are obtained which show greater solidity and lower brittleness than boron carbide obtained by compression under heat. These alloys have semiconductor properties, and can be utilized for the preparation of high temperature thermocouples. By the diffusion of boron into the surface of graphite samples, their corrosion resistance becomes noticeably higher, particularly at higher temperatures. The purpose of this work is to investigate the mechanism of diffusion and to determine its parameters. The object investigated is a cylindrical sample of spectroscopically pure graphite onto whose surface a 2 mm thick layer of a paste of amorphous boron is applied. After the samples are dried at 150°C, they are enclosed in a graphite shell and preheated in an atmosphere of hydrogen at 700 to 800°C, for 60 to 80 min. After this treatment the samples are subjected to metallographic, chemical, and x-ray analyses. Further, the reverse process of diffusion of carbon in boron is investigated. For this purpose, boron samples of a porosity of 36% are employed. They are prepared by compression of boron powder and sintering at 1900°C. In this case there results a saturation of the carbon samples with carbon in 30 minutes in a vacuum oven at 1940°C. Experiments show that in similar conditions the boron penetrates deeper in carbon (1.4 to 1.6 mm) than carbon does in boron (0.6 to 0.8 mm). This indicates a remarkably higher mobility of boron atoms. The diffusion coefficients are calculated to be $6.2 \cdot 10^{-6}$cm^2/sec (B → C) and $1.8 \cdot 10^{-6}$cm^2/sec (C → B). Numerical data for two samples showing boron content at different depths of the carbon sample (chemical analysis) are given. The boron concentration diminishes exponentially with depth. That a solid solution is formed due to diffusion, is shown by an x-ray analysis. Here the interplanar spacings of graphite lattice are measured as function of boron concentration. Further, the temperature dependence of diffusion of boron in graphite is investigated; $D = 3.02 \exp(-28625/T)$ is found to hold. (TCO)

14768 DIFFUSION IN METALS. P. G. Shewmon and G. R. Love (Carnegie Inst. of Tech., Pittsburgh). Ind. Eng. Chem., 53: No. 4, 325-8(Apr. 1961).

The theory of diffusion is reviewed. Five tables listing references to work on diffusion in pure metals, alloys, surfaces, liquids, and nonmetals are included. References are to work appearing from November 1, 1959 to November 1, 1960, with special emphasis on atomic processes in metals and the structures of diffused metals. (N.W.R.)

14769 THE PROBLEM OF THE VOLATILITY OF NIOBIUM OXIDES. I. V. Golubtsov, A. V. Lapitskii, and V. K. Shiryayev (Moscow State Univ.). Izvest. Vysshykh Ucheb. Zavedenii, Khim i Khim. Tekhnol., 3: 571-4(1960).

Measurements are made of the pressure of saturated vapors of Nb_2O_5 and NbO_2 in the temperature range of 1489 to 1905°K by using Nb^{95}. A vacuum furnace of the type (MVP-3M) and a Knudsen effusion chamber, the aperture and container of which are interchangeable and can consist of molybdenum, tungsten or ceramics, serve as testing apparatus. The temperature of the effusion chamber is measured with an optical (OPIIR-09) pyrometer. In addition to the Knudsen method, the vapor pressure of Nb_2O_5 is also measured by the flow method. The apparatus used consists of the MVP-3M furnace, the reaction tube, the installation for air drying, and a gasometer of the Patrikeyev system, type (UGSP-1). Niobium metal is dissolved, converted into the oxalate complex, precipitated with tannic acid after the addition of Nb^{95}, and annealed to Nb_2O_5. NbO_2 is obtained from $Nb + Nb_2O_5$ in the (TGV-1) furnace at 10^{-4} torr by heating up to 1250°C. The specific activities of the preparations are determined by means of a gamma tube of a (B-2) apparatus. The data for NbO_2 and Nb_2O_5 are listed. X-ray examinations show that NbO_2 is stable under the experimental conditions, and that the container material (molybdenum, tungsten, ceramics) has no influence on the results. For Nb_2O_5, the x-ray picture shows the appearance of NbO_2 above 1150°C. A thermal dissociation, therefore, takes place in vacuum at high temperatures: $Nb_2O_5 = 2NbO_2 + \frac{1}{2}O_2$. (TCO)

14770 INVESTIGATION OF RARE-EARTH DOPED BARIUM TITANATE. Victor J. Tennery and Ralph L. Cook (Univ. of Illinois, Urbana). J. Am. Ceram. Soc., 44: 187-93(Apr. 1961).

The effect of additions of 0.0015 to 0.0030 mole fraction of rare earth oxides on the d-c resistivity of sintered barium titanate was investigated. The substitution may be represented by $(X_2O_3)_M$ $(BaTiO_3)_{1-M}$, where X is the rare earth. The rare earths samarium, gadolinium, and holmium were introduced singly into the titanate, and the resistivity was measured as a function of temperature from −170° to +330°C. An anomalous increase near the tetragonal → cubic transition temperature at 120°C occurred which in some cases amounted to an increase in the resistivity of 4000 times the value in the tetragonal phase. The thermoelectric power of the material changed sign at the Curie temperature. The tetragonal phase exhibited n-type behavior whereas the cubic phase was p-type. The rhombohedral and orthorhombic phases exhibited conduction activation energies of the order of 0.2 ev whereas that in the tetragonal phase was approximately 0.1 ev. (auth)

14771 INTERACTION BETWEEN VACANCIES AND STACKING FAULT RIBBONS IN GRAPHITE. P. Delavignette and S. Amelinckx (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). J. Appl. Phys., 32: 554-5(Mar. 1961).

In graphite, unlike other crystals, the structure of dislocations is such that there is only a distortion of the layers of hexagons and neither free bonds nor jogs are associated with edge dislocations in the basal plane. An electron-optical study of quenched-in vacancies in graphite showed possibly a preferential condensation of vacancy loops in the stacking fault ribbons of the widely dissociated dislocations. It is shown that the disappearance of vacancies, i.e., the extension of the loops, is accompanied by glide of the partial dislocations, rather than climb; the prismatic dislocation climbs. It is suggested that the precipitation process contributes to the quench hardening and radiation hardening of graphite. (L.T.W.)

14772 SURFACE REACTIONS OF SINGLE CRYSTALS OF GRAPHITE. Gerhart R. Hennig (Argonne National Lab., Ill.). J. chim. phys., 58: 12-19(Jan. 1961). (In English)

Chemical reactions produce characteristic surface structures on single graphite crystals. These were studied with optical and electron microscopes. It was possible to determine differences of chemical reactivity between various faces of the crystals. In particular, oxidation is produced only at the edges and not on the surfaces of the phases unless lattice faults are introduced into the crystal. Some surface steps often appear during reaction with oxygen or carbon dioxide. The angle of these steps is, generally, but not always, related to the swiftness of the reaction. The steps tend to be almost vertical when the reaction is accelerated by water. Some studies with tritium tracer reveal a persistent retention of water by the graphite. Some pronounced surface effects are provoked by solid colloidal catalysts. Various faults and their effect on the reactivity were studied. It was observed that the spiral dislocations with a large Burgess vector augment the reactivity and produce cavities. The damage produced by radiation and the lattice faults caused by tempering produced profound modifications in the reaction kinetics and, consequently, changes in the surface structure. (tr-auth)

14773 EXAMINATION OF GRAPHITE OXIDATION BY INFRARED ABSORPTION, X-RAY DIFFRACTION, AND ELECTRON DIFFRACTION. C. Alexanian (Centre d'Etudes et Recherches des Charbonnages de France, Verneuil-en-Halatte, Oise). J. Chim. phys., 58: 133-40(Jan. 1961). (In French)

An attempt was made to determine the real composition of graphitic oxide by chemical analysis, infreared absorption, x-ray diffraction, and electron diffraction. The precise chemical composition could not be determined because the water is not completely eliminated before combustion. Also graphitic oxide is very hydrophilic. However, possible structural formulas are proposed. (J.S.R.)

14774 THE SYSTEM THORIUM−SILICON. A. Brown and J. J. Norreys (General Electric Co., Ltd., Wembley, Eng.). J. Inst. Metals, 89: 238-40(Mar. 1961).

The discovery of a low-temperature form of $ThSi_2$ when Th_3Si_2 is heated in liquid bismuth let to a detailed examination of the thorium-silicon system by both metallographic and x-ray diffraction techniques. Three new phases, including β-$ThSi_2$, the low-temperature hexagonal form of $ThSi_2$, were isolated. The other phases, α-Th_6Si_{11} and β-Th_6Si_{11}, are respectively the high-temperature tetragonal and low-temperature hexagonal forms of Th_6Si_{11}. The structural relationships between some of the phases in the system are discussed. A tentative phase diagram is included. (auth)

14775 THE STABILITY OF A TETRAGONAL PHASE GAMMA PRIME IN URANIUM−NIOBIUM ALLOYS. J. D. Browne and G. K. Williamson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inst. Metals, 89: 246-7(Mar. 1961).

The stability of a tetragonal phase gamma prime in U−Nb alloys was examined by x-ray diffractometry. Results indicate that there is no stable tetragonal phase, and that if this structure occurs at all, it does so less frequently than a cursory examination of the diffraction patterns would suggest. (N.W.R.)

14776 THE ALUMINIUM-RICH END OF THE ALUMINIUM−HAFNIUM EQUILIBRIUM DIAGRAM. Bhakta B. Rath, Ganesh P. Mohanty, and L. F. Mondolfo (Illinois Inst. of Tech., Chicago). J. Inst. Metals, 89: 248-9(Mar. 1961).

The aluminum end of the aluminum-hafnium diagram was investigated and found to be very similar to that of the aluminum-titanium and aluminum-zirconium systems. The compound $HfAl_3$, having a body-centered tetragonal structure with α = 3.986 and c = 17.05 A, reacts peritectically with aluminum to form an aluminum-rich solid solution. The peritectic temperature is 666.2 ± 0.5°C; the liquid solubility is 0.49 wt.% at the peritectic temperature and increases to 1.94% at 880°C. The solid solubility is 1.22% at the peritectic temperature and 0.86% at 430°C. A method of determining the solid solubility by measuring the resistivity directly at temperature was tested and proved satisfactory. (auth)

14777 ZIRCONIUM−COPPER ALLOY. HIGH STRENGTH AND CONDUCTIVITY. A. E. Moredock and D. K. Fox (Westinghouse Electric Corp. Pittsburgh). Metal Progr., 79: No. 4, 75-7(Apr. 1961).

Copper with 0.15% zirconium added combines good electrical conductivity with moderate strengths and hardness up to 350°C. Electrical and mechanical properties are compared with other alloys possessing conducting properties. (N.W.R.)

14778 NIOBIUM-20 W/O URANIUM, HIGH-TEMPERATURE METALLIC FUEL OF THE FUTURE. John A. De Mastry, Frederic R. Shober, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Nuclear Sci. and Eng., 9: 299-304(Mar. 1961).

An alloy containing niobium-20 wt.% uranium was devel-

oped for reactor fuel applications. The fabrication characteristics, mechanical properties, and corrosion behavior in air, CO_2, NaK, water, and steam were studied. After consumable arc melting, the alloy was successfully forged at 1370°C and rolled at 980°C to sheet. Representative specimens showed only slight reductions in hardness up to 900°C. The 0.2% offset yield strength was 93,000 psi at 24°C and 71,000 psi at 870°C. At a stress of 63,000 psi at 870°C, 200 hr were required to cause rupture. The corrosion life of niobium-20 wt.% uranium was superior to that of unalloyed niobium in 300°C air and in CO_2 at 316°C. In 1000 hr of exposure to 316°C water, this alloy exhibited corrosion rates only two or three (0.003 mg/cm^2/hr) times greater than that of Zircaloy-2 (0.001 mg/cm^2/hr). This alloy appears to be compatible with NaK at 870°C. (auth)

14779 A COMPARISON OF NIOBIUM–VANADIUM AND NIOBIUM–ZIRCONIUM ALLOYS FOR STRUCTURAL APPLICATIONS IN BOILING WATER REACTORS. D. L. Douglass (General Electric Co., Pleasanton, Calif.). Nuclear Sci. and Eng., 9: 391-8(Mar. 1961).

An evaluation of tensile, creep, hot hardness, fabrication, and corrosion data for Nb–V and Nb–Zr alloys was made to assess the merits and limitations of each alloy system for possible use as structural components of boiling water reactors. Niobium-vanadium alloys possessed far superior creep properties, equivalent tensile and hardness properties at elevated temperature, and superior corrosion behavior in high-temperature steam and water. With the exception of a higher neutron capture cross section, Nb–V alloys appeared to offer better potential for conditions existing in boiling water reactors. (auth)

14780 REGARDING "ELASTIC-PLASTIC THERMAL STRESSES IN TUBES SUBJECTED TO UNIFORM HEAT GENERATION EVALUATION OF EXPERIMENTAL RESULTS OBTAINED USING GRAPHITE TUBES." T. Kammash (Univ. of Michigan, Ann Arbor). Nuclear Sci. and Eng., 9: 408(Mar. 1961).

A cylindrical graphite tube with uniform internal heat generation, with the heat removed symmetrically from the exterior cylindrical surface, and with the axial thermal expansion of the tube completely suppressed was analyzed. Failures encountered in tests were caused by tensile stresses and strains in the graphite near the cooled surface. Fracture was caused by local strains from differential thermal expansions which were too high to accommodate the plastic flow and elastic deformation without elevation of stresses. (N.W.R.)

14781 CRACK FORMATION IN URANIUM. K. R. Merckx (General Electric Co., Richland, Wash.). Nuclear Sci. and Eng., 9: 413-14(Mar. 1961).

Post-irradiation thermal cycling of irradiated U can cause internal cracks. These cracks are similar in appearance to cracks observed in experimental U fuel elements. Since the cracks were formed in a disk with a small thermal gradient and were randomly oriented with respect to the geometry of the disk, strain incompatibilities due to anisotropic crystalline expansions must be the cause. (N.W.R.)

14782 ON THE VISCOSITY OF LIQUIDS. A. Carrelli and F. Porreca (Università, Naples). Nuovo cimento (10), 19: 197-209(Jan. 16, 1961). (In English)

An experimental method is outlined for the determination of an imaginary part, if it exists, in the viscosity coefficient. The researches, which are carried out by using a particular phasometer, allow actual measurements of this imaginary part, which in some liquids has a considerable value. (auth)

14783 ISOTOPE EFFECT IN INTERMETALLIC DIFFUSION. James G. Mullen (Univ. of Illinois, Urbana). Phys. Rev., 121: 1649-58(Mar. 15, 1961).

Ten measurements of the isotope effect for diffusion of Fe^{55} and Fe^{59} in pure single crystals of silver and copper were made over approximately a 300°C temperature interval below the melting point. The measured isotope effect was found to be about $^2/_3$, significantly less than the value of unity expected from conventional reaction rate theory. It is shown from Vineyard's extension of reaction rate theory that the measured isotope effect is to a good approximation a product of the Bardeen-Herring correlation factor and the fraction of the total translational kinetic energy associated with the diffusing tracer in a tracer-vacancy exchange. It is shown that the ring, interstitialcy, crowdion, and relaxion mechanisms are not responsible for diffusion in the systems studied. The three-frequency theory of correlation for vacancy diffusion in fcc lattices is extended to show that the relative frequency factors are completely specified by a knowledge of the correlation factor and the diffusion coefficients. An expression for the difference in the Arrhenius Q and the activation energy due to the temperature dependence of the correlation factor is derived. This theory is shown to be inconsistent with the observed isotope effect if many-body effects are neglected. It is shown that a "long-range" repulsive interaction between the vacancy and impurity would be necessary if the measured isotope effect is to be explained purely in terms of correlation. (auth)

14784 COMPRESSIBILITY, ZERO-POINT ENERGY, AND SPECIFIC HEAT IN SUPERCONDUCTORS. J. G. Daunt and J. L. Olsen (Ohio State Univ., Columbus). Phys. Rev. Letters, 6: No. 6, 267-9(Mar. 15, 1961).

It is reported that the lattice specific heats of certain superconductors, including Al, In, Pb, Nb, and Sn, are considerably smaller than lattice specific heats measured in the normal state. The changes in compressibility between the normal and superconducting states are calculated. It is shown from these calculations that variations in the Debye temperature (Θ_D) less than 0.01% may be responsible for the specific heat changes. It is suggested that the specific heat anomalies may be caused by a temperature dependence of the lattice zero-point energy. (T.F.H.)

14785 ABSENCE OF AN ISOTOPE EFFECT IN SUPERCONDUCTING RUTHENIUM. T. H. Gaballe, B. T. Matthias, G. W. Hull, Jr., and E. Corenzwit (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 6: No. 6, 275-7(Mar. 15, 1961).

The superconducting transition temperatures (T_{sc}) of ruthenium are measured, in an attempt to detect an isotope shift of T_{sc}. Enriched Ru^{99}, enriched Ru^{104}, natural Ru, and spectroscopic grade Ru^{101} were tested. The values of T_{sc} were within 0.002° of each other. It is believed that less than 10% of the normal isotope shift of T_{sc} is present in Ru. (T.F.H.)

14786 EXCHANGE POLARIZATION AND THE MAGNETIC INTERACTIONS OF RARE EARTH IONS. R. E. Watson (Avco, RAD, Wilmington, Mass.) and A. J. Freeman. Phys. Rev. Letters, 6: No. 6, 277-80(Mar. 15, 1961).

The contribution of spin or exchange polarization to the magnetic interaction of a rare earth ion with its neighbors and with its own conduction electrons is studied. The investigation utilizes analytic Hartree-Fock (H-F) calculations for Gd^{3+} and Gd^{+} ions, and spin-polarized H-F calculations for Gd^{3+}. It is suggested that the rare earth ions carry a "paired" electron spin density which is negative in the ion's outer reaches. The example of GdF_3 is con-

sidered, in which the F^- ion has a large internal magnetic field; this field enables measurements to be made which indicate that the Gd^{3+} ions have an apparent spin at GdF_3 interatomic distances that is antiparallel to the actual Gd^{3+} spin. The example of Al-rare earth intermetallic compounds is also studied, with the same results as those of the previous example. Effects of conduction electrons are considered. (T.F.H.)

14787 THE INFLUENCE OF THE ULTRASONIC ON THE LUMINESCENCE OF PHOSPHORS. B. B. Kudryavtsev, A. N. Medvedev, and A. P. Ponamarev (Krupskaya Pedagogical Inst., Moscow). Sbornik Primeneniya Ul'traakust. k Issledovan. Veshchest., No. 9, 139-45(1959).

Studies were carried out on the influence of the ultrasonics on the kinetics of luminescence of the light amount stored by ZnS • CdS • Cu and ZnS • Cu phosphors. The intensity of the luminescence process of the light stored by a phosphor increases with increasing ultrasonic intensity. The enhancing effect of the ultrasonic is caused in the main by the heating of the phosphor in consequence of the acoustic energy absorption. When considering the heating under the ultrasonic effect, it is necessary to take into consideration the local temperature increases, which can exceed the average temperature increase of the entire layer of the phosphor. (TCO)

14788 THE ZIRCONIUM-RICH PHASES IN THE SYSTEM Mg–Zr. Hans-Joachim Taschow and Franz Sauerwald (Martin Luther Universität, Halle-Wittenberg, Ger.). Z. anorg. u. allgem. Chem., 307: 123-36(Jan. 1961). (In German)

By diffusion annealing of the solid metals Mg and Zr at 614°C and by interaction between liquid Mg and compact Zr, the following phases were obtained: α-mixed-crystal, intermetallic phase δ with a homogeneity range from about 60 to 70% Zr, and α-Zr-mixed-crystal (solid solution of Mg in α-Zr) with a Mg concentration up to 15% at 800°C. Several alloys with concentrations of Zr from about 54 to 85% were prepared by powder metallurgy. There is a maximum of Brinell hardness at 50 to 70% Zr. Preliminary annealing experiments were made in the system Mg–Zn–Zr. (auth)

14789 THE KINETICS OF ZONE FORMATION PATTERNS IN SUPERSATURATED ALUMINUM–ZINC MIXED CRYSTALS. Volkmar Gerold and Werner Schweizer (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 52: 76-85(Jan. 1961). (In German)

The change in small angle x-ray scattering, due to the formation of Guinier-Preston zones, measured at room temperature and 50°C. It was shown that the zone formation is ruled by a metastable miscibility gap in the quenched solid solution. The metastable equilibrium state is reached after a very short time. The change of state measured usually is due to the coarsening of zones from small to larger sizes. The kinetics rate is controlled by the concentration of quenched-in vacancies, i.e., by their concentration immediately after the quench and their life time. The activation energies for the formation and the motion of quenched-in vacancies were determined. (auth)

14790 THE DIFFUSION OF RADON IN OXYGEN AFTER RECOIL INDICATION. Roland Lindner and Hansjoachim Matzke (Technische Hochschule, Göteborg). Z. Naturforsch, 15a: 1082-6(Dec. 1960). (In German)

The diffusion of radon in the oxides of aluminum, titanium, iron thorium, and uranium was measured by means of the new method of recoil indication (homogeneous distribution of Rn^{222} by means of α recoil from Ra^{226} adsorbed on the grain surface). The activation energy of the gas diffusion at high temperatures lies in the range 40 to 70 kcal mol^{-1}. The relationship of these results to the values of the radon method and the cation and anion self-diffusion in the oxides is discussed. (tr-auth)

14791 CONSTITUTION DIAGRAM AND PROPERTIES OF NIOBIUM–ALUMINUM ALLOYS. V. V. Baron and E. M. Savitskii. Zhur. Neorg. Khim., 6: 182-5(Jan. 1961). (In Russian)

The constitution diagram was plotted of Nb–Al alloy on the basis of microstructure, thermal, and diffraction analyses. Three compounds, Nb_3Al, Nb_2Al, and $NbAl_3$, were found. The Nb_3Al and Nb_2Al form by peritectic reaction at 2120 ± 10° and 1890 ± 10°C, while $NbAl_3$ crystallized from the melt at 1660 ± 10°C. Aluminum solubility in niobium at 2120°C is ~6 wt.%, dropping to 4.5% at room temperature. Aluminum increases the hardness and electroconductivity of niobium. With 8 to 45 wt.% Al, the hardness is 450 to 500 kg/mm^2, and the electroconductivity is 220 to 300 μ ohm cm. Alloys with solid solution of niobium have a higher corrosion resistance in water vapor at 400°C and 300 atm than niobium. The $NbAl_3$ compound is a superconductor. (R.V.J.)

14792 MECHANISM OF DISSOCIATION OF β SOLID SOLUTION OF Ti–Re ALLOYS. N. V. Ageev, O. G. Karpinskii, and L. A. Petrova. Zhur. Neorg. Khim., 6: 251-2(Jan. 1961). (In Russian)

The mechanism of dissociation of β-solid solution titanium with rhenium (19.91 wt.%) at 400°C was analyzed by metallographic and x-ray diffraction analyses. The results indicate the following scheme: $\beta \rightarrow \beta + \omega \rightarrow \beta + \alpha$. Hardness measurements show an increase that is more pronounced before the alloy reaches the ω phase than after; in the first instance it increases 97 kg/mm^2, in the second 30 kg/mm^2. The hardness of the Ti–Re β phase is explained by crystal lattice distortion. (R.V.J.)

14793 THERMODYNAMIC PROPERTIES OF LIQUID METAL SOLUTIONS OF ANTIMONY–CADMIUM–TIN. M. F. Lantratov. Zhur. Priklad. Khim., 34: 130-8(Jan. 1961). (In Russian)

The activity coefficients, partial values ΔZ^* for all components of the Sb–Cd–Sn solution, and the integral magnitudes ΔZ^* for the double boundary systems Cd–Sb and Cd–Sn and the triple system as a whole were calculated. Relatively small positive-negative deflections from the saturated system potential were observed in liquid Sb–Cb–Sn solutions. The positive deflection region is adjacent to the boundary Cd–Sn, while the region of highest negative deflection is near Cd–Sb. (R.V.J.)

14794 PROPERTIES OF ELEMENTAL AND COMPOUND SEMICONDUCTORS. Harry C. Gatos, ed. Proceedings of a Technical Conference, American Institute of Mining, Metallurgical, and Petroleum Engineers, Boston, Massachusetts, August 31–September 2, 1959. New York, Interscience Publishers, 1960. 348p.

The papers presented at the conference, discussions of those papers, and a panel discussion on Role of Dislocations in Device Properties were included. Semiconductor metallurgical and chemical properties, including crystalline defects, were considered. Physical aspects, including solid-state, surface, and dislocation effects, were also examined. Applications for semiconductor devices were investigated. (T.F.H.)

14795 MAGNESIUM ALLOYS HAVING A HIGH RESISTANCE TO PERMANENT CREEP DEFORMATION AT ELEVATED TEMPERATURES. Hans Joachim Fuchs. British Patent 847,992. Jan. 27, 1959.

A magnesium alloy having high resistance to creep deformation at high temperatures contains 2 to 10% aluminum, 0 to 4% zinc, 0.001 to 0.5% magnesium, and 0.5 to 3% calcium, with copper and silicon impurities not exceeding 0.5% each. It may also contain beryllium up to 0.005%. Other properties which are improved over those of previous alloys are castability, reduced tendency to burn, and reduced crack deformation (especially if the iron content is at least 0.01%); there is no change in corrosion resistance. Four examples of such alloys are given, together with elongation tests at 200°C for times up to 50 hr. (D.L.C.)

14796 METHOD OF LUBRICATING CERTAIN INSTALLATIONS. (to Shell Research Ltd.). French Patent 1.195.313. May 19, 1959.

Radiation-resistant greases are prepared from lubricating mineral oils having a viscosity-gravity constant of at least 0.85 (preferably at least 0.88) and inorganic gelling agents, preferably colloidal silica or an aluminum silicate. The resistance of the grease to the action of water is increased by making the agents hydrophobic, e.g., by coating the particles with a polymeric silicon compound (e.g., dimethyldiethoxysilane) or by reacting them with a lower alcohol. Hardening of the grease can be prevented by adding a small quantity of a 1,3- or 1,2-diol, which contains 6 or more carbon atoms. (NPO)

14797 RADIATION RESISTANT LUBRICATING OILS. (to Sacony Mobil Oil Co., Inc.). French Patent 1.195.534. May 19, 1959.

The increase of the viscosity of lubricating oils under high-energy irradiation is largely prevented by adding a small quantity of a soluble polymeric hydrocarbon which contains benzene nuclei. A preferred composition consists of a common lubricating oil with a kinematic viscosity of 32 to 600 centistokes at 37.8°C to which 0.5 to 1% by weight of a nonylpolystyrene (mole wt. about 75,000) is added. (NPO)

14798 PROCESS FOR THE MANUFACTURE OF NUCLEAR FUEL MATERIALS AND PRODUCTS, AND MATERIALS AND PRODUCTS OBTAINED BY THAT PROCESS. Philippe Galmiche and Andre Hivert (to Office National d'Etudes et de Recherches Aeronautiques). French Patent 1,198,870. June 15, 1959.

"Plastic" Cr is prepared by giving Cr powder a halogen treatment, followed if desired by fritting. Bonding of "plastic" Cr with fissionable material (which may be enriched), such as U-metal powder, UO_2 powder (which may be prefritted), UO_2-containing cermets with Fe, Ni or Mo, U nitride, etc., offers a means of preparing fuel materials and products of excellent ductile, mechanical and oxidation-proof qualities. The procedure for preparing the fuel is to bring a mixture of constituents (19 examples are given) under pressure, during or after which the temperature is held at 800 to 1350°C for 1 to 6 hours. The resulting material shows a high degree of compactness. In order to render its surface oxidation-proof the fuel is once more brought under pressure at an elevated temperature, both somewhat higher than the first time. Depending on the composition of the material, preparation of an anti-corrosive coating or can is effected by de-uranization in a halogen atm., by chromization in the presence of Cr grains and Cr-halogen salts, by treatment with "plastic" Cr in an Ar atm., by schoopage with Fe–Cr, Ni–Cr or Fe–Al, by cementation with Cr–Al or by canning and brazing with Nimonic 75. Resistance against oxidation is obtained for temperatures varying between 500 and 900°C. Fuels consisting of metal alloys, e.g. of U and Cr, must also contain Mo (30–50%) as a bonding and as an anti-corrosion component. Metallo-ceramic fuels contain mostly 20–30% U oxide or nitride and 80–70% of a metal component, either Cr or Fe. If the latter is used, a coating of Fe–Cr is necessary. (NPO)

14799 METHOD OF PREPARING CARBON WITH A LOW PERMEABILITY. (to The General Electric Co., Ltd.). French Patent 1.206.007. Aug. 24, 1959.

Pieces of industrial carbon, notably moderator carbon, are heated at 800 to 1200°C, preferably by induction or resistance heating, in a stream of methane, propane, acetylene, or benzene vapor. (NPO)

14800 METHODS OF PREPARING CARBON WITH A LOW PERMEABILITY. (The General Electric Co., Ltd., French Patent 1.216.583. Nov. 30, 1959.

Pieces of industrial carbon, notably moderator carbon, are evacuated and then impregnated under pressure with a sugar solution (d = 1.4 g/ml) or with molten sugar. The impregnant is carbonized at 175 to 300°C under a N_2 or He pressure of about 84 kg/cm^2 (dyne/cm^2). One or more of these treatments reduce the permeability 50- to 1000-fold. (NPO)

Radiation Effects

14801 (AERE-R-3564) THE RADIATION AND THERMAL STABILITY OF SOME POTENTIAL ORGANIC MODERATOR-COOLANTS. PART IV. CHEMICAL DETERMINATIONS ON THE MARK I ORGANIC LOOP IN BEPO. T. H. Bates, R. F. Cumberland, W. G. Burns, and C. R. Reed (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1960. 12p.

The growth of high boiler residue concentration in Santowax R in the BEPO Mark I loop was followed with time for 3,000 hours. The initial G value for conversion to H.B.R. was 0.40, at 275°C. Measurements on static samples in silica capsules were made at 300 and 350°C, and extrapolation of the results to 275°C gives an initial G value of 0.46. The difference of ~13% between the static and loop experiments is thought to be caused by differences in neutron energy spectra in the two experiments. The results indicate that determinations in silica capsules are applicable to a dynamic system in metal pipes. (auth)

14802 (BNL-5218) ANNEALING OF THE DEFECTS AND COLOR CENTERS IN UNIRRADIATED AND IN REACTOR IRRADIATED Al_2O_3. Paul W. Levy (Brookhaven National Lab., Upton, N. Y.). [1961]. 32p.

Before irradiation, synthetic Al_2O_3 contains at least 3 color centers in the 3 to 6 ev region which can be removed by heating at 1800°C for 5 hr. Two or three additional centers are formed by gamma irradiation. If the 1800°C annealing is interrupted and the crystals colored to saturation by 5×10^5 r gamma rays, very nearly the same absorption spectrum is obtained after each successive saturation coloring. Reactor-induced color can be removed by heating up to 730°C, but a large fraction of the removed color at 6.02 ev can be restored by gamma irradiation and thus provides an approximate measure of the defect concentration in the crystal. The reactor-induced bands anneal in separate stages at different temperatures. The results are discussed with respect to defect formation. (D.L.C.)

14803 (IDO-16656) A PROPOSAL FOR THE CONTROLLED RELEASE OF STORED ENERGY IN THE MTR REFLECTOR GRAPHITE. E. Fast, E. O. Smith, and J. D. Ford (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 9, 1959. Contract AT(10-1)-205. 21p.

A study of the stored energy buildup in the MTR reflector

graphite and a program of controlled energy release is presented. Calculations, based on measurements of samples from the pebble zone show that an inadvertent spontaneous stored energy release would cause a temperature rise of 90°F in the pebble zone. The maximum transient structure temperatures resulting from a worst credible accidental release of energy would be less than allowable at present (except for possible damage to neutron detector chambers) but could exceed this value in five years. It is proposed that the stored energy be released by thermal annealing. The reflector graphite is heated by reducing the air flow and operating the reactor at low power until a temperature of 500°F is reached, at which point the reactor is scrammed. Normal cooling is provided after 15 minutes at peak anneal temperature or if the temperature rises to 600°F. Health physics monitoring includes continuous measurement of particulate and of C^{14} activity. Sustained oxidation, if it occurs, will be detected with a CO_2 monitor and controlled by smothering. An estimated 2 or 3 days of MTR operating time will be needed of which the anneal itself will require about one day. (auth)

14804 (LMSD-703735) PROTON DAMAGE TO SOLAR CELLS. K. T. Chow and E. A. Lodi (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). July 1960. 35p. Contract AFO4(647)-564. 31p.

An evaluation was made of the performance of commercially available silicon solar cells for use as a power source in the space radiation field surrounding the earth. The experiment was specifically designed to provide information on the proton radiation encountered by solar cells operating in space. The following observations were made: transient effects on the cells using an average proton flux of 10^4 to 10^6 protons/cm^2/sec; and the integrated proton flux required to reduce the power output of the cell by 25%. The experiments were carried out with 3- and 12-Mev protons. A gradual degradation was observed in the power output, open-circuit voltage, and short-circuit current. The results indicated that a 25% reduction in maximum power output of the cell occurred at integrated fluxes of $\sim 5 \times 10^9$ and 2×10^{11} protons/cm^2 for 3- and 12-Mev protons, respectively. The cells were further irradiated to obtain a reduction in maximum power output of about 40 to 50%. Room-temperature annealing of the cells was observed with no significant changes occurring. The proton source, the apparatus for measuring the electrical output of the solar cell, and the results of the experiment are presented. A comparison with theoretical considerations of radiation damage to solar cells is discussed. (auth)

14805 (NYO-2719) SYNTHESIS OF SEMI-CONDUCTOR MATERIALS BY RADIATION INDUCED REACTIONS. Qua Quarterly Status Report No. 4 [for] Period February 1, 1960–April 30, 1960. Kalman Held and Richard Goldman (TRG, Syosset, N. Y.). 8p. Contract AT(30-1)-2392. (TRG-132-QTR-4)

Sample preparation, filling sample containers, gamma irradiation, and analysis of gaseous end products are reported. The in-pile irradiation of silane samples is described. Work was continued on the thermal decomposition of silane. (W.L.H.)

14806 (ORNL-3027) THE PHYSICAL PROPERTIES OF ROCK SALT AS INFLUENCED BY GAMMA RAYS. B. D. Gunter and F. L. Parker (Oak Ridge National Lab., Tenn.). Mar. 20, 1961. Contract W-7405-eng-26. 71p.

Thesis submitted to Vanderbilt Univ.

The response of aggregates of natural rock salt crystals to gamma radiation was determined for a spectra of exposure doses from 10^6 to 5×10^8 roentgens. Emphasis was placed on those physical properties which determine the structural stability of salt. The compressive strength, yield strength, modulus of elasticity, and apparent elastic limit were investigated. Short-term creep tests were also made. Data are presented in both tabular and graphic form. Both bedded and dome salt were studied. Bedded salt was studied with force applied both parallel to and perpendicular to the planes of stratification. Specimens were tested at room temperature and at 200°C to establish temperature effects. The plasticity of both unirradiated and irradiated rock salt exhibited a pronounced increase with temperature. Within the statistical variation of the experiment, radiation caused only minor changes in the physical properties of rock salt. (auth)

14807 (PAN-185/ChR) IZMENENIE FIZIKO-KHIMICHESKIKH SVOISTV STEKOL POD DEISTVIEM GAMMA-IZELUCHENIYA. I. ISSLEDOVANIE PROZRACHNOSTI IZVESTKOVO-NATRIEVOGO STEKLA OBLUCHENNOGO BOL'SHIMI DOZAMI GAMMA-IZLUCHENIYA. (Alterations of Physical and Chemical Properties of Glasses Under Influence of γ-radiation. I. Investigation of Transparence of Soda Lime Glass Treated with Big Doses of γ-rays). Yu. Rotnitski and S. Mints (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Oct. 1960. 6p.

An investigation was conducted of the influence of large doses of gamma rays on the coloration and transparency of soda-lime glass such that the relaxation phenomenon caused by the irradiated patterns was retained. An analysis of the relaxation curve indicates that three processes are supposed to proceed at different rates during the relaxation. (auth)

14808 (TID-3559) IRRADIATION TESTING OF UO_2. A Literature Search. William E. Bost (Office of Technical Information, AEC). Nov. 1960. 23p.

Included are 167 references to unclassified reports and scientific journals on irradiation testing of unalloyed UO_2. Irradiation behavior and effects, heat transfer calculations, fission-gas release, post-irradiation examination, and irradiation capsule design are the subject areas covered. (auth)

14809 (TID-11864) RADIATION DAMAGE STUDIES USING THE TECHNIQUES OF ELECTRON-SPIN PARAMAGNETIC RESONANCE. Annual Progress Report, Period Covered May 1, 1960–April 30, 1961. P. J. Bray and A. O. Williams, Jr. (Brown Univ., Providence). Mar. 1, 1961. Contract AT(30-1)-2024. 26p.

Work on the hyperfine structure observed in the ESPR of irradiated LiF was concluded. The ESPR of conduction electrons in heavily irradiated crystals was sought with success in the case of NaF. ESPR doublets of atomic hydrogen and tritium were observed in neutron-irradiated LiF single crystals which were subjected to thermal annealing. Weak signals from unannealed samples were found only in cases where the irradiation was carried out at higher temperatures. Hydrogen is presumed to be introduced by the breaking up of OH radicals trapped in the LiF crystal during its growth, and tritium is introduced in the lattice during neutron irradiation by the reaction, $Li^6(n,\alpha)H^3$. Effort was directed toward the interpretation of the ESPR spectra of irradiated borosilicate glasses obtained previously. It is thought that the broad line with the 5-line hyperfine structure is caused by the paramagnetic centers produced in the networks of boron and alkali oxides in the glasses. The sharp resonance that appeared in the case of neutron irradiation was identified as a trapped electron resonance in the silica network in the borosilicate commercial glasses. (auth)

14810 (VDIT-22) RADIATION EFFECTS ON ALUMINUM, MAGNESIUM, ZIRCONIUM, AND THEIR ALLOYS. A Literature Survey. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Feb. 1961. 36p.

An annotated bibliography is given consisting of 87 references on radiation effects on aluminum, magnesium, zirconium, and their alloys. (B.O.G.)

14811 EFFECT OF RADIATION ON SEMI-CONDUCTORS: RECOMBINATION CENTERS INTRODUCED IN GERMANIUM BY ELECTRONS AT 2 Mev. Pierre Baruch (Ecole Normale Supérieure, Paris). Ann. phys. (13), 6: 21-79(Jan.-Feb. 1961). (In French)

A study is made of the recombination centers introduced in Ge by 2-Mev electrons. Three methods of study were used: electron paramagnetic resonance, the "electron-voltaic" effect, and the decline of the conductivity induced by fast electrons or photons. The first method gave no results of any value. The study of the variations of the lifetime as a function of the radiation dose received showed in certain cases a phase in which the conductivity increased after the normal expected initial decrease. This phenomenon is connected to the decrease of the number of free electrons, following the induction of acceptor centers by the bombardment. The recombination can be described by a mechanism with a single level. It is supposed that the center responsible for the recombination is one of the elements of a pair of faults very close to each other and carrying an opposite charge. This model is inapplicable if the bombardment is made at the temperature of liquid air. The recovery between 0 and 100°C is attributed to the diffusion and annihilation of a very mobile fault. (J.S.R.)

14812 THE EFFECTS OF RADIATION ON THE ELECTROCHEMICAL BEHAVIOR OF 1X18H9T STEEL. V. V. Gerasimov and V. N. Aleksandrova. Atomnaya Energ., 10: 164-6(Feb. 1961). (In Russian)

A specially designed vitreous electrolytic cell, 20 mm in diameter and 400 mm high, was used in the investigation of radiation effects on the electrochemical behavior of 1X18H9T steel specimen (0.07 wt.% C; 1.23 wt.% Mn; 19.2 wt.% Cr; 10.5 wt.% Ni; and 0.53 wt.% Ti). The experiments were carried out with a cell placed in an active reactor zone with 10^{12} neutrons/cm^2 · sec flux at 80 to 90°C. The irradiation did not affect the kinetics of the anode process of 1X18H9T steel in 0.01N sodium sulfate. The polarization curves are plotted. (R.V.J.)

14813 THE CHARACTERISTICS OF IRRADIATED GLASSES. Zdenek Spurny. Atomnaya Energ., 10: 172-3 (Feb. 1961). (In Russian)

Characteristics of standard optical glass measured with a Co^{60} source considering various factors are tabulated. However, the results are uncertain due to the high radiosensitivity of the given factors. A more exact determination of the factors must be found. (R.V.J.)

14814 CRYOGENICS AND RADIATION DAMAGE. L. Weil (Institut Fourier, Grenoble, France). Cryogenics, 1: No. 3, 129-34(Mar. 1961). (In English)

Radiation damage and detection, and the recovery of defects in the solid state are discussed with particular emphasis on temperature effects. Low temperature measurements are shown to be a most efficient tool in this field of radiation damage. (N.W.R.)

14815 THE INFLUENCE OF ADHESION LEVELS ON THE RELAXATION OF NON-EQUILIBRIUM CONDUCTIVITY IN GERMANIUM IRRADIATED WITH GAMMA RAYS. S. M. Ryvkin and I. D. Yaroshetskii (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Fiz. Tverdogo Tela, 2: 1966-77(1960).

The effect of γ-induced defects on the temperature dependence of the relaxation time of the conductivity of n-type germanium is determined. The method and the experimental arrangement are discussed. n-type Ge single crystals of 5 · 5 · 15 mm, etched with (SR-4) to reduce the rate of surface recombination, serve as samples. They are exposed to γ-rays of 120 r/sec (Co^{60}) at 20°C. The concentration of the resulting structural defects is determined from the formula $N_t = \sigma N_{Ge} \Phi$, where Φ is the γ-flux per cm^2 of the sample surface, N_{Ge} the concentration of the germanium atoms, and σ the cross section of defect formation which is assumed to be $\sigma = 4.3$ mb. The sample is placed in a cryostat between the poles of an electromagnet which can generate a field of up to 4,000 gauss. This cryostat permits a change in temperature from room temperature to that of liquid nitrogen. The temperature dependence is given of the relaxation time, τ', of non-equilibrium conductivity as the function $\ln\tau' = f(1/T)$. With increasing irradiation, a dropping slope of the curves having a minimum can be observed. After passing through this minimum, they steeply rise again. Thus, the relaxation time first decreases with dropping temperature and again increases with further dropping temperature. $\ln\tau' = f(1/T)$ is also given for the same sample, but for $N_t = 1.5 \cdot 10^{13} cm^{-3}$ in a wide temperature range. The curve starts in the minimum, rises linearly and quickly, and after having passed through a peak, it slowly drops. The results are discussed in detail and compared with theory. The curves $\ln\tau' = f(1/T)$ may be well represented in three characteristic parts: drop, rise, and near saturation. The position ΔE_S of the recombination levels of these γ-induced defects in the forbidden band are determined from the slopes of curves. The authors find that $\Delta E_S = 0.2$ ev (distance of the S-level from the conduction band). The hole trapping cross section on the S-level at room temperature is found to be $3.5 \cdot 10^{-15} cm^2$. The position of the second level (M) is determined by its distance from the valency band ΔE_M; it is found that $\Delta E_M = 0.24$ ev. The values for the second sample deviate but little from those of the first sample; the second sample has a somewhat lower resistivity. The numerical values are compiled in a table. The S-levels are recombination levels, while the M-levels play the part of adhesion levels under certain conditions. At low temperatures, the adhesion levels become recombination levels. (TCO)

14816 EFFECT OF FAST NEUTRONS ON CRYSTALLINE QUARTZ AND VITREOUS SILICA. Guy Mayer and Marcel Lecomte (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium, 21: 846-52(Dec. 1960). (In French)

A dose of 2×10^{20} fast neutrons cm^{-2} transforms crystalline quartz and vitreous silica into the same isotropic substance. Measurements on density, thermal expansion, internal energy, and elastic and piezoelectric constants were used to follow this transformation. Before reaching the isotropic state, the irradiated quartz crystals assume the symmetry characteristics of β-quartz. On reheating, and according to the neutron dose received, these crystals can be transformed either into vitreous silica or again into natural quartz or into another structure which is described. (auth)

14817 A COMPARATIVE EVALUATION OF THE EFFECTIVENESS OF VARIOUS SOURCES OF NUCLEAR EMISSIONS FOR THE VULCANIZATION PROCESSES OF TIRES BY IRRADIATION. A. Kh. Berger, M. Ya. Kaplunov,

B. I. Vainshtein, and Ya. M. Vizel' (Karpov Scientific Inst. of Physics and Chemistry, Moscow; Scientific Research Inst. of the Tire Industry, Moscow; and Inst. of Chemical Engineering, [Moscow]). Kauchuk i Rezina, No. 4, 17-22 (1960).

These problems must be solved in order to apply the process of vulcanization by irradiation to the tubeless 6.70–15 tire of the "Volga" automobile. The following problems were investigated: an evaluation of the field uniformity of the doses on the cross-section of the tread; a computation of the radiation time at a given energy output of the emitter or estimating the energy output of the emitter according to the given vulcanization period (the energy of the emitter is taken to be the γ-emission energy); determining the power efficiency factor in each individual case of the system's γ-emission efficiency output. The average integral dose of radiation needed for the vulcanization process is taken to be $25 \cdot 10^6$r. Two types of emission sources are investigated, namely, a circulating contour (nuclear reactor-radiation installation) in which the γ-emitter is an indium-gallium alloy with 16.5 at.% of indium, and heat-emitting wastes of a nuclear reactor with a heat capacity of 10 Mw. Each source investigated is described in detail. Several conclusions are drawn. The comparative evaluation of the two sources for radiation vulcanization of tires shows that a circulating contour power efficiency factor ($\eta \sim 2.0\%$) has greater possibilities as a γ-emitter. There are several technical difficulties, however, as compared to the waste product source. When using waste products of a VVR–Ts type reactor, it is more expedient to design the emitter in the form of two parallel planes ($\eta \sim 0.3\%$). If the emitter is built in the form of 2 co-axial cylinders, $\eta \sim 0.2\%$. The power efficiency factor of the γ-emission for the investigated cases can be increased if a special shape of the press-die is developed and a structural material chosen which ensures minimum absorption of the γ-emission. The data obtained can be used as the basis for computing the apparatus of radiation vulcanization for test batches of tires. (TCO)

14818 AGGREGATION AND DISPERSAL OF RADIATION DAMAGE IN GRAPHITE. W. N. Reynolds, P. A. Thrower, and B. E. Sheldon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 189: 824-6 (Mar. 11, 1961).

Crystals of natural graphite were irradiated in high-flux reactors to doses of about 4.8×10^{20} n/cm^2 at temperatures in the range 150 to 650°C. The crystals were heat treated at 1500°C before irradiation. The damage effects at various temperatures are described. Annealing the low-temperature damage caused defects to form clusters, with the effect becoming more marked at about 1000°C. Damage incurred at 150°C began to disappear rapidly at annealing temperatures above 1500°C, and at 1700°C there is little evidence of damage. Specimens annealed at higher temperatures were indistinguishable from unirradiated material. Results confirm the formation of highly stable complexes by the annealing of low-temperature damage. (C.H.)

14819 EFFECTS OF X RAYS ON THE GROWTH OF KCl. D. N. Kumar (Bose Research Inst., Calcutta). Naturwissenschaften, 48: 47(1961). (In English)

The effect of irradiation on the specific gravity of KCl during crystallization was studied. In one series of experiments supersaturated solutions were irradiated from the beginning. In a second experiment the solution was irradiated only after the formation of minute crystals. Both solutions received 143,000 r. The specific gravity of both crystals, measured after 11 days of irradiation, was found to be less than that of normal KCl. The decreased specific gravity was attributed to radioinduced expansion of the crystal lattice. (J.S.R.)

14820 ELECTRICAL IRRADIATION EFFECTS IN SOLID DIELECTRICS. Bernhard Gross and Preston V. Murphy (Instituto Nacional de Technologia, Rio de Janeiro). Nukleonik, 2: 279-85(Dec. 1960). (In English)

The results of a systematic study of the effects of radiation on the electrical properties of solid dielectrics are summarized. The topics discussed include electric breakdown, charge storage, differential range distribution of monoenergetic electrons, transmission currents, thermovoltaic effects, Compton current, gamma-powered detectors and power sources, and current induction by neutrons. (J.S.R.)

14821 STIMULATED SPIN-ECHO MEASUREMENT OF CROSS-RELAXATION IN NEUTRON-IRRADIATED CALCITE. L. Kent Wanlass and J. Wakabayashi (Univ. of California, Berkeley). Phys. Rev. Letters, 6: No. 6, 271-3 (Mar. 15, 1961).

The stimulated spin-echo technique is described for measuring cross-relaxation times (T) in cases for which the spin-lattice relaxation time (T_1) is considerably greater than T. A system is described that delivers pulses as short as 1 μsec to a sample of neutron-irradiated calcite at 1.5°K. An initial pulse rotates the spin system through 90°. The echo to this pulse (8-ball echo) decays with the spin-spin relaxation time $T_2 \cong 18$ μsec. A second pulse brings about a stimulated echo which normally decays with time constant $T_1 \cong 5$ sec; the observed time constant is 600 μsec. This short time constant is attributed to the cross-relaxation. The experimental results are discussed in terms of cross-relaxation phenomena. (T.F.H.)

14822 STUDY OF DIFFUSION IN SOME POLYMERS. III. IRREVERSIBLE VARIATIONS OF THE DIFFUSION CHARACTERISTICS DUE TO THE ACTION OF GAMMA RADIATION OF Co^{60} ON THE POLYMER. N. S. Tikhomirova, Yu. M. Malinskii, and V. L. Karpov (Scientific Research Inst. of Plastics, USSR and Karpov Inst. of Physics and Chemistry, USSR). Vysokomolekulyarnye Soyedineniya 2: 1335-48(1960).

Films of polyethylene, SKS-30 rubber, polyamide, polytetrafluoroethylene, and hydroxymethyl polyamide ($^2/_{10}$) are studied. The properties of these films as functions of irradiation doses up to 1250 Mrad at 25, 40, 60 and 70°C are studied. The properties examined include permeability to gases (P), diffusivity (D), and solubility of argon and helium. Observed results are interpreted in terms of polymer crosslinking, microstructure defects, and free radical action. (TCO)

14823 STUDY OF DIFFUSION PROCESSES IN SOME POLYMERS. IV. REVERSIBLE VARIATIONS OF THE DIFFUSION CHARACTERISTICS UNDER THE ACTION OF IRRADIATION. N. S. Tikhomirova, Yu. M. Malinskii, and V. L. Karpov (Scientific Research of Plastics, USSR and Karpov Inst. of Physics and Chemistry, USSR). Vysokomolekyluarnye Soyedineniya, 2: 1349-59(1960).

Permeability experiments on films of polyethylene and polytetrafluoroethylene are described. The films are stretched across a diffusion cell filled with helium or xenon at 700 mm Hg, and the space above the films is evacuated to 2 to 5.10^{-3} mm Hg. The permeability is measured with a sensitive manometer. The permeability of the films to helium and xenon is measured as a function of irradiation time, at intensities up to 730 r/sec, using a cobalt-60 gamma source. (TCO)

14824 X-RAY STUDY OF $ZrO_2 \cdot 2TeO$ FORMED BY DIFFUSION OF Zr AND Te IN AIR. R. P. Agarwala, M. C. Naik, and Jugdish Shankar (Atomic Energy Establishment, Trombay, India). Z. anorg. u. allgem. Chem., 307: 202–4 (Jan. 1961). (In English)

By heating Zr and Te or ZrO_2 and Te in air at 750°C, the compound $ZrO_2 \cdot 2TeO$ results. The crystal parameters were determined. (auth)

14825 PROCESS OF BONDING MATERIALS. (to U. S. Atomic Energy Commission). French Patent 1,210,904. Oct. 5, 1959.

Two materials are brought into close contact with each other and firmly pressed together during a period of time varying according to need between 1 and 40 hours, in an inert atmosphere (Ar or He) at a pressure between 140 and 1400 kg/cm^2 [dyne/cm^2]. The temperature is high enough for one of the materials to flow, but well below the melting point of either of the materials present. The method permits the manufacture not only of fuel rods, but also of fuel plates, with well bonded protecting layers of exactly the desired thickness. Examples are given of the following combinations of materials: U–Zr alloy–Zr, U–Zr, Ni–Zr, U alloy–Ni, UO_2 (graphite clad)–Zr, a metal hydride (Mo clad)–stainless steel. (NPO)

General and Miscellaneous

14826 (AFCRL-90) INVESTIGATIONS OF RARE-EARTH OXIDE CATHODES. Scientific Report No. 6. J. B. Baker and G. B. Gaines (Battelle Memorial Inst., Columbus, Ohio). Feb. 1, 1961. Contract AF19(604)-5691. 8p.

It was found that the inclusion of a small amount of nitrocellulose in a coating composed of 75% Nd_2O_3 and 25% Gd_2O_3 had no appreciable effect upon the emission, except, perhaps, to cause activation to occur at a lower temperature. A cathode containing 90% Gd_2O_3 and 10% Nd_2O_3 gave an emission level less than 0.1 amp-cm^2 at 1400°C. Initial indications show that the high emission from Gd_2O_3 can be reproduced. The reason for the high activation is not yet known. (auth)

14827 (ANL-6305) EBWR CORE 1A PHYSICS ANALYSIS. R. Avery, K. Almenas, C. Carson, H. Iskenderian, and C. Kelber (Argonne National Lab., Ill.). Feb. 1961. Contract W-31-109-eng-38. 76p.

The studies were primarily directed toward selection of the optimum loading for Core 1A and a prediction of its properties. Included are analyses of some relevant experiments on Core 1, and preliminary modifications of Core 1 to Core 1A. The factors which must be considered for the optimum loading determination are discussed. Four different loading patterns were investigated, which were considered to span the numerous possibilities. Adequate cold shutdown was found to be almost unobtainable without the use of boric acid. For this reason, and because the heat transfer and stability limitations are severe, greater weight was given to heat transfer as opposed to control requirements. The use of boron-stainless steel poison strips fastened to the sides of the spike elements is considered insofar as in improving the loading from either the heat transfer or control standpoint. The relative advantages and disadvantages of the use of stainless steel fuel followers as opposed to Zircaloy followers are discussed. (B.O.G.)

14828 (JINR-P-511) K VOPROSY O MODEL'NOM GAMIL'TONIANE V TEORII SVERKHPROVODIMOSTI. (On the Question of the Model Hamiltonian in the Theory of Superconductivity). N. N. Bogolyubov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. and Akademiya Nauk S.S.S.R. Institut Matematiki im. V. A. Stelkova). 1960. 99p.

The model Hamiltonian in the theory of superconductivity was examined and its general properties investigated. Minimum eigenvalues were calculated for cases where the Hamiltonian is a maximum and where it is a minimum. The asymptotic value of Green's functions was calculated for $V > 0$ and for $V = 0$. Proofs concerning several relations used are given in one appendix, while another appendix contains a discussion of the principle of weakening correlations of a system in a state of statistical equilibrium. (TTT)

14829 (MND-P-2101-II) SNAP III—THERMOELECTRIC GENERATOR ENVIRONMENTAL TEST. VOLUME II. Louis W. Gross (Martin Co. Nuclear Div., Baltimore). Oct. 1959. Decl. Sept. 21, 1960. 50p.

The thermoelectric generator operated for about 250 hr during the entire test program. The efficiency varied ~5% of the total performance during the vibration cycle, and remained relatively stable during the acceleration and shock tests. Recovery was complete in all cases. Oscillatory d-c superimposed on the d-c output of the generator was observed during the shock and vibration tests, and disappeared when the environmental forces were discontinued. The maximum d-c ripple was 7.4 millivolts rms in the y-Plane during the shock and vibration cycles. It was concluded that SNAP III thermoelectric generator No. 1G5 is reliable in environments simulating the WS-117 L Vehicle. (auth)

14830 (MND-P-2184) PRELIMINARY OPERATIONAI HAZARDS SUMMARY REPORT FOR THE TASK 2 THERMOELECTRIC GENERATOR. George P. Dix, Jr. (Martin Co. Nuclear Div., Baltimore). Dec. 1959. Decl. Oct. 20, 1960. Contract AT(30-3)217. 161p.

The operational hazards associated with the use of an isotope-fueled auxiliary power unit for a satellite mission are described. The effects of missile abort on the generator are discussed. The generator design is described, and the properties of the various fuel forms are investigated. The characteristics of the fuel capsules and the provisions for biological shielding are also described. Integration of the generator into a typical missile system is discussed. Hazards and procedures of transporting and handling the fuel cores from fabrication to launching are considered. Aborted missions are defined, and the forces acting on the generator during abort are described. (W.D.M.)

14831 (NASA-TN-D-679) TWO-DIMENSIONAL ION BEAMS WITH SMALL LATERAL SPREADING. Harold Mirels (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Mar. 1961. 34p.

Two-dimensional ion beams were considered in which the characteristic axial length of the unneutralized portion of the ion beam $\bar{l}$ is small compared with the characteristic axial length $\bar{L}$ of the accelerator that produced the beam. The first problem studied was that of a beam downstream of an ion accelerator. The beam was assumed to be neutralized a distance $\bar{l}$ downstream of this electrode, with $(\bar{l}/\bar{L})^2 \ll 1$. It was found that, except for $(\bar{d}/\bar{l})^2 \to 0$, the spreading of the beam is less than that indicated by the paraxial equation when the axial variation of the perturbation potential is neglected. (The $\bar{d}$ is the beam semi-width.) The spreading in the beam decreased as $\bar{d}/\bar{l}$ increased. The thrust, due to the momentum of the ion beam, and the drag, due to the electrostatic forces acting on the electrode, were determined for a variety of beam widths. The ratio of drag to thrust varied from 0.02 to 0.25ϵ for values of $\bar{d}/\bar{l}$ from 0.01 to 100. The effect of slightly overaccelerating the ion beam in order to keep electrons from the electrode was also determined. A second problem investigated was that of a two-dimensional unneutralized ion beam between the accelerating and decelerating electrodes of an ion rocket. Numerical spreading results were obtained for the case where the two electrodes are essentially at the same potential, and the trends were similar to those obtained for the semi-infinite beam. Linear superposition

can be used to apply the present results to an array of two-dimensional beams. (auth)

14832 (NASA-TN-D-716) AN EXPERIMENTAL STUDY OF CONTINUOUS PLASMA FLOWS DRIVEN BY A CONFINED ARC IN A TRANSVERSE MAGNETIC FIELD. R. L. Barger, J. D. Brooks, and W. D. Beasley (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Mar. 1961. 25p.

A crossed-field, continuous-flow plasma accelerator was built and operated. The highest maximum measured velocity of the flow, driven by the interaction of the electric and magnetic fields, was about 500 meters per second. Some of the problems discussed are ion slip, stability and uniformity of the discharge, effect of the magnetic field on electron emission, use of preionization, and electrode contamination. (auth)

14833 (NBS-TN-56) A BIBLIOGRAPHY OF THE PHYSICAL EQUILIBRIA AND RELATED PROPERTIES OF SOME CRYOGENIC SYSTEMS. Technical Note No. 56. Thomas M. Flynn (National Bureau of Standards. Boulder Labs., Boulder Colo.). May 1960. 123p. (PB-161557)

A bibliography of approximately 700 references is presented on the physical equilibria and related properties of several important cryogenic systems. The systems considered are the pure components and mixtures of: hydrogen, helium, nitrogen, carbon dioxide, carbon monoxide, methane, ethane, and propane. The information is presented in three principal parts: phenomena, properties, and bibliography of references. (auth)

14834 (ORNL-3083) ELECTRONUCLEAR RESEARCH DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 16, 1961. (Oak Ridge National Lab., Tenn.). Apr. 3, 1961. Contract W-7405-eng-26. 80p.

Research with 28-Mev N^{3+} ions from the ORNL 63-Inch Cyclotron included studies of elastic and inelastic scattering, of angular distributions from transfer reactions, and of nuclear reactions resulting in the evaporation of alpha particles and protons. The research program associated with the 22-Mev protons from the ORNL 86-Inch Cyclotron included studies of bound states of neutrons, the investigation of energy levels in neutron-deficient rare-earth nuclei, and the production of neutron-deficient radioisotopes. Theoretical studies are being made for the interpretation of both proton-induced and nitrogen-induced reactions with distorted-wave Born approximation calculations and with the optical model. Fabrication and assembly of Cyclotron Analogue II are nearing completion. The building for the Oak Ridge Isochronous Cyclotron was completed. The final design work is well advanced; the major heavy components were fabricated and are being installed. (For preceding period see ORNL-3047.) (auth)

14835 (SB-427) MAGNETOSTRICTION. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Aug. 1960. 6p.

A bibliography is presented on magnetostriction covering reports added to the OTS collection during the period 1946 to September 1960. (M.C.G.)

14836 (SC-4537(RR)) A HOMING PARACHUTE SYSTEM. Milton T. Kane, H. K. Dicken, and R. C. Buehler (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 37p.

The technological problems and practical engineering aspects associated with the design and testing of a homing parachute system are presented. This device consists of a solid, flat, circular parachute with an open gore which provides a horizontal thrust component, causing the parachute to glide. An electromechanical control system employing a direction-finding antenna is used to control the orientation of the open gore with respect to a ground transmitter so that the parachute glides toward the transmitter. (auth)

14837 (SCTM-269-60(51)) ANALYSIS OF THE MEASURED PRESSURE ERROR DUE TO BREATHING OF A PRESSURE PROBE. Glen W. Zumwalt (Sandia Corp., Albuquerque, N. Mex.). Aug. 1960. 16p.

An analysis of the effect of "breathing" on the pressure indicated by a static probe is presented. Good agreement was found with some experimental data. (auth)

14838 (SRB-60-9) PHYSICS OF ULTRASONICS AND HYPERSONICS IN SOLIDS. An Annotated Bibliography. A. A. Beltran, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Sept. 1960. 96p.

The generation, detection, and propagation of ultrasonic and hypersonic radiation in solids are covered. Piezoelectric sources of ultrasonic radiation; optical, mechanical, and electrical methods of detection; measurement equipment, methods, and results; and propagation, attenuation, and absorption are included. 193 references. (auth)

14839 (SRB-61-7) EPITAXIAL GROWTH. An Annotated Bibliography. Helen M. Abbott, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Feb. 1961. 24p.

This bibliography contains selected references pertaining to the epitaxial growth processes, including such factors as crystal growth and formation, vapor growth, twinning, and thin film processes. References are arranged alphabetically by author. The following sources were used: Chemical Abstracts: 1947 to 1959, Science Abstracts (A): 1953 to 1960, ASTIA-Technical Abstract Bulletin, Electronic Design: 1959 to 1960, Electronics: 1959 to 1960, Bell Laboratories Record: 1959 to 1960, and IBM Journal: 1959 to 1960. (auth)

14840 (TID-12093) LOW ENERGY NUCLEAR PHYSICS. Progress Report, June 1, 1960 to May 31, 1961. F. G. Brickwedde and R. R. Roy (Pennsylvania State Univ., University Park. Coll. of Chemistry and Physics). Feb. 1961. Contract AT(30-1)-2399. 309p.

A description is given of the computer and reactor facilities along with the studies completed and underway in experimental and theoretical low-energy nuclear physics. Experimental work completed includes: γ-γ directional correlations in Cs^{133} and Nd^{147}, the angular distribution of 2.6-Mev γ rays from $Pb^{208}(n,n'\gamma)Pb^{208}$ reactions, photonuclear studies with monoenergetic γ rays from thermal neutron capture, decay of Zn^{71} isomers, survey of γ branching ratios, β-γ angular correlation spectrometer, x-ray spectrum and triplet cross sections, angular and momentum distribution of recoil electrons in triplet production, differential pair production cross sections by photons at 5 to 90 Mev, triplet differential cross sections, multiplet production by photons, study of fission phenomena by multigrid ionization chambers, angular correlations and excited states of fission fragments, and the reaction $Pt(n,\alpha)Os$. Theoretical studies included: relativistic particle dynamics; classical self-consistent nuclear models; nuclear spin-orbit splitting as a one nucleon effect; T, C, P invariance; analysis of low energy N-N scattering; analysis of p-p scattering at 95 and 310 Mev; and the invalidity of the Rafael analysis for moderate-energy N-N scattering. (B.O.G.)

14841 (TID-12149) BEHAVIOR OF PLASMOIDS IN MAGNETIC FIELDS. W. H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). [nd]. 41p.

An examination is given of the process whereby the plasmoid leaves behind plasma tracks as it traverses a magnetic field in a vacuum of 10^{-5}mm kg. A discussion is given of the change in velocity of a plasmoid when it encounters a magnetic field with a gradient. An analysis was made of the behavior of a plasma loop current near the button gun. The projection of a plasma across a magnetic field in the presence of a background conducting media was studied. A description is given of the dragging of magnetic field lines when plasmas are projected along the axis of symmetry of a field which has a radial component. Considerations are discussed for the collision of plasmoids where rotation is involved. (B.O.G.)

14842 (TID-12159) NUCLEAR PHYSICS RESEARCH AT COLUMBIA UNIVERSITY, PEGRAM NUCLEAR PHYSICS LABORATORIES. (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Mar. 1, 1961. Contract AT(30-1)-GEN-72. 70p.

The nuclear research program to be carried out at Columbia Univ. is reported. The report is divided into four sections dealing with neutron physics, charged particles (particularly He^3 reactions), beta and gamma spectroscopy, and macroscopic neutron physics. (D.L.C.)

14843 (TID-12334) THERMOLUMINESCENCE BEHAVIOR IN INORGANIC CRYSTALS. Final Report. James K. Rieke (Wisconsin. Univ., Madison). May 1954. Contract AT(11-1)-178. 72p.

The thermoluminescence of several crystal phases of aluminum oxide was studied as a function of the degree of calcination, and four thermoluminescence peaks were observed. Three were associated with characteristic lattice imperfections, and one with the sodium ion impurity concentration. A new luminescence emission phenomenon was observed in partially calcined alumina crystals. The thermoluminescence was activated by visible light, and was released only at high temperature. The imperfections responsible for the latter thermoluminescence phenomenon are believed to be surface bound hydroxyl radicals. Forty other inorganic compounds were investigated for thermoluminescence activity. The experiments were carried out to determine what type of crystals were most thermoluminescent and deserved more intensive investigation. In general crystals with small cations and small anions were observed to have the highest thermoluminescence efficiency at temperatures greater than room temperature. Alpha particle bombardment of lithium fluoride produced unusual and interesting thermoluminescence effects. Alpha particles hitting lithium fluoride crystals penetrated only a few ten thousandths of an inch, and secondary collision products penetrated only slightly further. Thermoluminescence was observed at distances up to 0.2 inches from the source of excitation. From estimates of the rate of diffusion of the thermoluminescence centers, they were associated with the diffusion of excitons and vacancy pairs through the crystal lattice. Comparisons between the irradiated top sections of the crystal and the bottom unirradiated sections of the crystal by optical absorption measurements indicated that the thermoluminescence centers are not the same as the F and M centers. Other experiments indicated that F centers have different thermal stabilities but identical absorption spectra. The same was true for M centers. The differences are explained in terms of multiple coalesced imperfections. Measurements of vacancy pair diffusion by thermoluminescence provides a new and sensitive method of studying diffusion processes in single crystal phosphors. In addition, the thermoluminescence of plate glass and the quenching properties of iron impurities in the glass were investigated. The oxidation state of the iron impurity markedly affected the x-ray produced coloration of the glass but did not affect the thermoluminescence efficiency. High iron concentrations almost completely quenched any thermoluminescence. From these experiments it is suggested that the color centers and thermoluminescence centers are not the same in the plate glass studied. Cadmium iodide exhibited a peculiar luminescence phenomenon at minus 25 degrees centigrade that was radioinduced. (M.C.G.)

14844 (WT-769) EVALUATION OF A THERMAL ABSORBING CARBON SMOKE SCREEN. Elmer H. Engquist (Chemical and Radiological Labs., Army Chemical Center, Md.). Feb. 1954. Decl. Nov. 25, 1960. Project 8.4-2 of OPERATION UPSHOT-KNOTHOLE. 42p.

Experiments were carried out to obtain a better understanding of the method of formation and the characteristics of the precursor shock wave obtained on some prior atomic weapons tests. The modification of a shock wave was emphasized through the medium of a heated air layer provided by the absorption of thermal radiation by a carbon smoke screen. Supplementary measurements were made to determine the attenuation of thermal radiation by a thermal-absorbing smoke screen. Analysis of the pressure curves indicated that the blast wave was markedly modified by the presence of the carbon smoke screen. The maximum pressure in the carbon smoke screen was higher than in the clear area from approximately 900 to 3000 ft. The wave form was markedly modified from that of a normal shock wave in both the smoke screen and clear area, though the distance over which this modification was present varied between the smoke and clear area. In the clear area the normal shock front appeared at about 3000 ft while in the smoke it appeared at about 1500 ft. The time of arrival of the initial shock disturbance at any position in precursor region was later, by as much as 20% in the smoke screen. The net effect of the smoke screen on the blast was to modify the precursor type wave and reduce the range over which the precursor effect would normally occur. In general, the smoke screen reduced the thermal effect. Blast data were more nearly like that which would be obtained from a non-thermally heated reflecting surface. The thermal flux was reduced from 47.0 ± 4.0 cal/cm^2 to 1.2 ± 0.1 cal/cm^2. The measured attenuation of thermal radiation at a ground station 2640 ft from air zero was $97.4 \pm 0.3\%$. (auth)

14845 (AEC-tr-3972) ADVANCES IN PHYSICAL SCIENCES. Translation of Uspekhi Fizicheskikh Nauk, Volume 62, Nos. 1-4, 1957. 674p. (PST Cat. -111)

Twenty-two papers are presented in a cover-to-cover translation of this journal. Five of these papers are covered by separate abstracts. (M.C.G.)

14846 (AEC-tr-3972(p.372-445)) THEORY OF THE VAVILOV-CHERENKOV EFFECT. B. M. Bolotovskii. Translated from Uspekhi Fiz. Nauk, 62: No. 3, 201-46 (1957).

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, Abstract no. 12308.

14847 (AEC-tr-4519) EFFECT OF THERMAL IRRADIATION BACKGROUND ON SPECTROSCOPIC PROCESSES. B. I. Stepanov. Translated from Optika i Spektroskopiya 3: 3-8(1957). 12p. (Includes original, 6p.).

An analysis was made and formulas were derived for estimating the effects of thermal irradiation of a source, receiver, and a cell containing the substance being investigated, on the results of spectrometric measurements. (auth)

14848 (AFCRL-19) CORRELATION FUNCTION OF A SIGNAL PASSING THROUGH A MEDIUM WITH RANDOMLY MOVING INHOMOGENEITIES. G. I. Priimak. Translated from Izvest. Vysshykh Ucheb. Zavedenii, Radiofiz., 3: 778-88(1960). 14p.

The problem of the correlation function of a signal passing through a medium with randomly moving inhomogeneities was analyzed. The analysis was made for the acoustic case although it also refers to the case of radio wave propagation. (auth)

14849 (JPRS-7357) LINEAR APPROXIMATION OF VELOCITY IN THE CASE OF ONE-DIMENSIONAL MOTION OF A PLASMA WITH FINITE CONDUCTIVITY. L. B. Levitin and K. P. Stanyukovich. Translated from Doklady Akad. Nauk S.S.S.R., 134: 300-3(Sept. 11, 1960). 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 10221.

14850 CONTRIBUTION TO THE STUDY OF L SPECTRA EXCITED BY ELECTRON BOMBARDMENT OF SOME HEAVY ELEMENTS. INTENSITY RATIOS AND VARIATIONS AS A FUNCTION OF Z. Charles Victor (Institut du Radium, Paris). Ann. phys. (13), 6: 183-210(Jan.-Feb. 1961). (In French)

A recording method which, when coupled with a bent-crystal spectrograph, permits the direct measurement of the number of photons of an x-ray L spectrum was studied and developed. This technique was applied to the determination of the intensity ratios of the L lines of tungsten, platinum, gold, lead, bismuth, thorium, and uranium. The results can be directly compared with the x-ray emission spectra obtained during transmutation. The ionization probabilities of the three L subshells vary with the mode of excitation. Thus, the intensity ratios of the lines of different level of an L spectrum emitted as a result of internal conversion or of electron capture are very different from those obtained by exterior bombardments. The variation, as a function of the atomic number, of the emission probabilities was studied relative to each level taken separately. These results were compared to the experimental and theoretical results of other investigators. The ratios of the sums of the intensity of the rays were studied relative to each of the sub-levels. With respect to the ratio between the levels L_{III} and L_I a maximum was found for the numbers 82 to 83. This maximum should be interpretated as a result of the variation as a function of Z of the Coster-Kronig effect. (tr-auth)

14851 PRODUCTION OF AN AZIMUTHALLY VARYING MAGNETIC FIELD. R. A. Meshcherov and E. S. Mironov. Atomnaya Energ., 10: 127-30(Feb. 1961). (In Russian)

A method is suggested for calculating the pole surface configuration for magnetic fields with azimuthal variations of given depth and with a determined law of variations along the radius of the mean intensity of the field. Descriptions are given of the magnetic field model for a 1.5-m cyclotron with azimuthal magnetic field variation. (tr-auth)

14852 A BETA RAY SOURCE BASED ON Au^{198} FOR USE IN STUDIES OF PHYSICAL PROPERTIES OF MATERIALS UNDER IRRADIATION. M. A. Mokul'skii and Yu. S. Lazurkin. Atomnaya Energ., 10: 160-2(Feb. 1961). (In Russian)

A small-dimension (100 mm^3) beta source with a golden-tip bronze-needle source, in a 10 mm long, 0.2 mm thick golden foil tube of 0.85 mm outside diameter is described. The golden tip irradiated at a thermal neutron flux of 1.6×10^{13} cm^{-2}/sec acquired 3×10^{16} atoms of Au^{198} decaying as $Au^{198} \rightarrow \beta^- + Hg^{198}$, with a half life 64.6 hours and maximum β spectrum energy of 0.97 Mev, followed by 0.411 Mev γ emission. The resulting amount of Au^{198} is equal to ~25 c. The dose distribution along the radius of a teflon specimen irradiated by the gold needle and the electron paramagnetic resonance spectra of irradiated polymethylmethacrylate are plotted. A release of ~10% of electron energy was observed outside the source which means that a 1 mm thick layer receives a mean dose of ~200 to 250 r/sec. The contribution of γ rays in a 1 mm thick teflon specimen is ~16%. (R.V.J.)

14853 A METHOD OF STUDYING SLOWING-DOWN PROCESSES FOR FISSION FRAGMENTS IN METALS. N. A. Protopopov, Yu. B. Shishkin, V. M. Kul'gavchuk, and V. I. Sobolev. Atomnaya Energ., 10: 166-8(Feb. 1961). (In Russian)

The processes of slowing down of fission products in metals and alloys are analyzed considering the curve of specific energy losses as a function of the particle range. Descriptions are given of a device for studying the passage of U^{235} fission products in metals. The principal part of the scheme is the ionization fission chamber; the pulses of both channels are transmitted through the amplifier to the double coincidence scheme with a resolving time of 0.5 μsec. The chamber consists of U_3O_8 preparation (~0.1 mg/cm^2 enriched up to 90% with U^{235}) covering a 0.4 mg/cm^2 thick aluminum foil and placed in the middle of the chamber. The combined fission chamber and coincidence scheme eliminate the errors due to the false pulses from γ quanta and nuclear recoils and enable measurements to be made in a reactor with thermal neutron flux from 10^6 to 10^8 neutrons/$cm^2 \cdot$ sec. The measurements of the specific energy losses of light and heavy fission fragments in metals by the replacement method are discussed, and specific losses and yield of light fission fragments are plotted as a function of their range in gold and in aluminum. (R.V.J.)

14854 SOLUTION TO THE KINETIC EQUATION FOR A MEDIUM HAVING A POINT SOURCE EMITTING IN A SINGLE DIRECTION. E. B. Breshenkova and V. V. Orlov. Atomnaya Energ., 10: 175-7(Feb. 1961). (In Russian)

The solution of the kinetic equation for a medium with a point source emitting in a single direction is reduced by means of the theorem of reciprocity, to the solution of the conjugated kinetic equation for a medium with isotropic source. The latter is composed of three independent variables, and can be resolved by the method of moments. (R.V.J.)

14855 PHONON DRAG IN LEAD. A. V. Gold and W. B. Pearson (National Research Council, Ottawa). Can. J. Phys., 39: 445-51(Mar. 1961). (NRC-6175)

Measurements were made of the thermoelectric power of dilute alloys of lead with the solutes Cd, In, Sn, Tl, and Bi in order to test a plausible hypothesis that much of the thermoelectric behavior of pure lead at low temperatures can be ascribed to phonon drag. The results are qualitatively consistent with the phonon-drag picture only if it is assumed that the scattering of phonons by these impurities depends more critically on the valence difference between solvent and solute than on the mass difference. (auth)

14856 EXCITATION OF THE FIRST NEGATIVE SYSTEM OF O_2^+ BY A PROTON BEAM IN AIR AND OXYGEN. L. Herman, H. I. S. Ferguson, and R. W. Nicholls (Univ. of Western Ontario, London, Can.). Can. J. Phys., 39: 476 (Mar. 1961).

The reported results concern the excitation of the bands of the O_2^+ first negative ($b^4 \Sigma_g^- - a^4 \pi_u$) system by 40-kev proton beams in air and oxygen at low pressures. The

emission spectra were investigated over the pressure range 10^{-1} to 10^{-3} mm Hg and over the wavelength range 2300 to 7000A. The identified spectral features, main emitters N^+, O^+, N_2^+, and O_2^+, are shown. Nitrogen features show up in the oxygen spectra because of an intrinsic leakage of air into the collision chamber. In air, the O_2^+ bands are much weaker than those of N_2^+. The proton beam is very sharply defined at these low pressures and the bands arise from the center of the beam, evidently from direct proton excitation. (N.W.R.)

14857 MOSSBAUER EFFECT IN PYRITES AND MARCASSITE. Ionel Solomon (Centre d'Etudes Nucléaires, Saclay, France). Compt. rend., 250: 3828-30(June 8, 1960). (CEA-1622). (In French)

Observation of the Mössbauer effect in pyrites and marcassite enables determination of the value of the quadrupolar interaction of the excited state of Fe^{57} ($I' = 3/2$) with the crystalline field. A "chemical isomeric" displacement is also observed. (auth)

14858 DETERMINATION OF THE SENSITIVITY OF EMULSIONS PREPARED BY BROMINATION OF A SILVER HYDROSOL. Max Morand, Jean-Claude Fayolle, and Simone Desprez-Rebaud. Compt. rend., 252: 542-3(Jan. 23, 1961). (In French)

The sensitivity of the emulsions prepared by bromination of a silver hydrosol is between 600 and 700 ev, a value slightly less than that of Ilford C_2 emulsions. (tr-auth)

14859 THE CHANGE IN THE CATHODE SPUTTERING COEFFICIENT AS A FUNCTION OF THE INCIDENCE ANGLE OF THE IONS ON THE TARGET. V. A. Molchanov and V. G. Tel'kovskii (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 136: 801-2(Feb. 1, 1961). (In Russian)

Polycrystalline copper samples were bombarded with 27-kev argon ions at a current density of 1 to 2 m amp/cm^2 over a wide range of beam incidence angles (0 to 84°) on an experimental piece of equipment similar to a large mass-spectrometer with double focusing of the ion beam in a sectored magnetic field. The sputtering coefficient was calculated from the loss in weight of the sample, the strength of the ion current and the time of irradiation. Successive sputtering of the same sample showed that the sputtering coefficient increases monotonically and becomes constant, only after the surface of the sample has become roughened. The increase in the sputtering coefficient is 25% for technical-grade copper and 15% for copper with a low content of impurities. The sputtering coefficient was found to be inversely proportional to the cosine of the incidence angle up to 70°C, and falls off at higher incidence angles. The decrease in the sputtering coefficient at the higher incidence angles can be explained by the reflection of fast charged particles which carry away a significant fraction of the energy. (TTT)

14860 SPUTTERING YIELDS OF METALS FOR Ar^+ AND Ne^+ IONS WITH ENERGIES FROM 50 TO 600 ev. Nils Laegreid and G. K. Wehner (General Mills, Inc., Minneapolis). J. Appl. Phys., 32: 365-9(Mar. 1961).

Sputtering yields for polycrystalline metal and semiconductor targets under normally incident Ar^+ and Ne^+ ion bombardment were measured in the energy range from 50 to 600 ev. The yields (atoms/ion) were determined by measuring the weight loss of spherical targets immersed like large negative Langmuir probes in a dense low-pressure plasma (2 to 5 μ in Ar and ~40 μ in Ne), created in a demountable thermionic cathode, low-voltage discharge tube. The yields were found to be independent of gas pressure and ion current density. Sputtering sets in substantially at approximately the same ion energy for the various metal-gas combinations (40 to 60 ev) but with increasing ion energy rises differently for different materials. Comparing various materials, it is found that the yields increase consistently as the d shells are filled, with Cu, Ag, and Au having the highest yields. (auth)

14861 ETCH EFFECTS FROM OBLIQUE-INCIDENCE ION BOMBARDMENT. G. D. Magnuson, B. B. Meckel, and P. A. Harkins (Convair, San Diego, Calif.). J. Appl. Phys., 32: 369-74(Mar. 1961).

It has been found that metallic surfaces of Cu, Au, Al, W, Ta, Mo, and Ni when bombarded with 500-v Hg^+ ions at angles of incidence other than zero exhibit a definite surface structure or pattern. This pattern consists of hillocks or spires oriented parallel to the direction of the incoming ion beam. In Cu and Ni, steps oriented perpendicularly to the ion beam were also found. This surface pattern provides visual evidence that the sputtering process at low ion energies is a momentum transfer process. Since redeposition of sputtered atoms on the hillocks and steps could be quite large, angle of incidence yield measurements could be in error unless they are made before formation of the hillocks. (auth)

14862 CALCULATION OF X-RAY INTENSITIES FROM ELECTRON PROBE SPECIMENS. L. S. Birks (U. S. Naval Research Lab., Washington, D. C.). J. Appl. Phys., 32: 387-90(Mar. 1961).

Complete calibration curves may be prepared for electron probe specimens of any matrix composition without the aid of known calibration standards. When there is no fluorescent excitation of the desired element by matrix components, the equation for relative x-ray intensity is simply $I_A/I_{100} = F_A W_A / F_{A_{100}}$, where I_A and I_{100} are the intensities from weight fraction W_A and from 100% of the element, respectively; F_A and $F_{A_{100}}$ are values of an "intensity variable" at W_A and 100% of the desired element. Values of F for all elements from Ti to Au (and probably from Al to Ti as well) for any takeoff angle ψ, and for any matrix composition, can be obtained from a single intensity-variable curve that will, of course, be valid for any electron probe instrument operated in the 25-30 kev range. When there is fluorescent excitation of the desired element A by characteristic radiation from matrix element B, the equation is the same except for a fluorescent correction term K_F, which is evaluated from tabulated values of absorption coefficients and excitation efficiencies. Then $I_A/I_{100} = F_A W_A(1 + K_F)/F_{A_{100}}$. For the NRL electron probe operated in the 25 to 30 kev range, x-ray intensities calculated from these equations agreed with measured values to within 5% of the amount present even when very strong fluorescence by matrix elements occurred. (auth)

14863 EFFECT OF PRESSURE ON emf OF THERMOCOUPLES. F. P. Bundy (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 32: 483-8(Mar. 1961).

"Pressure" thermal emf's have been measured for constantan, Pt, Ni, alumel, Pt 10% Rh, Cu, chromel, and Ni 18% Mo for a ΔT of 100°C over a pressure range 0 to 72 kbar. Corrections due to pressure for common thermocouples made of pairs of these metals have been deduced. A number of thermocouple pairs have been compared at temperatures up to 1200°C and pressures up to 58 kbar. Below 200 to 300° the deviations between them agree quite well with the absolute data on single metals taken at ΔT of 100°C. At higher temperatures the deviations diminish and generally reverse. It appears that the deviation δT of the readings of two thermocouples at a given pressure follow

roughly the relationship $\delta T = A(P)\Delta T + B(P)\Delta T^2$, where ΔT is the temperature interval in the pressurized zone, A(P) and B(P) are functions of pressure (roughly linear), and B(P) is generally opposite in sign to A(P) and is large enough to dominate the A(P) term at higher ΔT's. (auth)

14864 DYNAMIC STABILITY OF A CONDUCTING, CYLINDRICAL SHELL IN A MAGNETIC FIELD. J. G. Linhart (Euratom-CNEN, Frascati, Italy). J. Appl. Phys., 32: 500-5(Mar. 1961).

The dynamic stability of a thin, perfectly conducting cylindrical shell in axial and azimuthal magnetic fields is investigated by means of the method of normal modes. It is found that in cases where a growth of a surface perturbation is indicated, the e-folding time corresponds to the time required for the shell to collapse radially. Where stability is predicted, an initial surface perturbation can be shown to execute an oscillatory and damped motion. (auth)

14865 PROCEEDINGS OF THE SIXTH SYMPOSIUM ON MAGNETISM AND MAGNETIC MATERIALS, NOVEMBER 14-17, 1960., NEW YORK, NEW YORK. J. Appl. Phys., 32: No. 3, Suppl., 407p.(Mar. 1961).

149 papers are included; separate abstracts have been prepared for 12. (N.W.R.)

14866 MAGNETIC ORDERING IN THE FERROMAGNETIC RARE-EARTH METALS. Kei Yosida and Hirosi Miwa (Tokyo Univ.). J. Appl. Phys., 32: No. 3, Suppl., 8S-12S(Mar. 1961).

The ferromagnetic rare earth metals show the magnetic transition from the ferromagnetic state to the antiferromagnetic state. The possibility of this kind of magnetic transition between spin arrangements is discussed on the basis of the spin wave approximation. The transition from the ferromagnetic to the helical spin arrangement which has recently been observed in dysprosium and holmium can occur when a large axial anisotropy field exists. The temperature dependence and the field dependence of the pitch of the helical structure are calculated on the same standpoint of the spin wave theory. (auth)

14867 NEUTRON DIFFRACTION INVESTIGATION OF MAGNETIC ORDERING IN DYSPROSIUM. M. K. Wilkinson, W. C. Koehler, E. O. Wollan, and J. W. Cable (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 32: No. 3, Suppl., 48S-9S(Mar. 1961).

Neutron diffraction measurements on a single crystal of dysprosium show that the magnetic structure in the antiferromagnetic region between 179° and 87°K closely resembles a helical-type arrangement of the atomic moments. In this arrangement the moments within a hexagonal layer are aligned parallel and point in a direction perpendicular to the c axis of the crystal. The moment direction in adjacent layers is rotated by a specific angle which is dependent on the temperature of the sample. A slight modification of this structure exists below about 140°K, and a transition to ferromagnetism occurs at 87°K. (auth)

14868 NEUTRON DIFFRACTION STUDY OF METALLIC ERBIUM. J. W. Cable, E. O. Wollan, W. C. Koehler, and M. K. Wilkinson (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 32: No. 3, Suppl., 49S-50S(Mar. 1961).

Neutron diffraction measurements were made on erbium single crystals in the temperature range 298° to 4.2°K. The material is antiferromagnetic below 80°K and ferromagnetic below 20°K. In the antiferromagnetic region, the magnetic scattering consists of satellite reflections corresponding to a modulation of the magnetic scattering amplitude along the c axis. The spacing and intensity distribution of these satellites show two distinct subregions of antiferromagnetism. In the upper region, between 80° and 52°K, the data suggest a sinusoidal modulation of the magnitude of the c-axis component of magnetic moment with a period of 3.5 c_0. Between 52° and 20°K the wavelength of the modulation varies continuously from 3.5° c_0 to 4.0 c_0. In addition, there is a squaring up of the modulation and a simultaneous ordering of the component of the moment normal to the c axis. Below 20°K the material is basically ferromagnetic with a moment of 7.2 μ_B directed parallel to the c axis. (auth)

14869 NMR AND THE CONDUCTION ELECTRON POLARIZATION IN RARE-EARTH METALS. V. Jaccarino (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 32: No. 3, Suppl., 102S-6S(Mar. 1961).

The magnitude and sign of the conduction electron polarization in rare earth intermetallic compounds were determined with the use of NMR techniques. Large, temperature-dependent Knight shifts of the Al^{27} NMR were found in XAl_2 (X ≡ rare-earth ion). These observations may be explained by assuming that a negative exchange interaction of ~ 0.1 ev exists between the localized *f* electrons of the rare-earth ion and the conduction electrons. (auth)

14870 PRESSURE AND TEMPERATURE DEPENDENCE OF THE Fe^{57} NUCLEAR MAGNETIC RESONANCE FREQUENCY IN FERROMAGNETIC IRON. G. B. Benedek and J. Armstrong (Harvard Univ., Cambridge, Mass.). J. Appl. Phys. 32: No. 3, Suppl., 106S-10S(Mar. 1961).

The pressure dependence of the Fe^{57} nuclear magnetic resonance frequency ν in ferromagnetic iron was measured from 1 to 10,000 kg/cm^2 at −77°, 0°, and 84.2°C. From these measurements the volume dependence of ν was obtained, and measurements of $\nu(T)_{P=1\ atm}$ were corrected for the effects of thermal expansion. By making a similar correction for the effect of thermal expansion on the temperature dependence of the saturation magnetization σ, it was found that, at constant volume, the hyperfine coupling constant A in the relation $\nu = A\sigma$ is an explicit function of the temperature. Thus, measurements of the temperature dependence of ν, even when corrected to constant volume, do not give accurately the temperature dependence of σ. The results of a theory based on Stoner's collective electron model for the d electrons are presented to account for the temperature dependence of A. (auth)

14871 MÖSSBAUER EFFECT: APPLICATIONS TO MAGNETISM. G. K. Wertheim (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 32: No. 3, Suppl., 110S-17S(Mar. 1961).

The magnetic field at iron nuclei was determined in the ferromagnetic transition metals (Fe 3.42×10^5 gauss, Co 3.12×10^5 gauss, Ni 2.80×10^5 gauss at 0°K), but no hyperfine structure was observed down to 4°K in the antiferromagnetic transition metals, Mn and Cr. In the case of yttrium-iron garnet the fields at the iron atoms in the two types of sites were obtained (tetrahedral 3.9×10^5 gauss, octahedral 4.7×10^5 gauss). The most complete analysis so far was made in FeF_2 where the magnetic field in the antiferromagnetic state ($H_{T=0} = 3.40 \times 10^5$ gauss) and the quadrupole splitting in the paramagnetic state (31.2 Mc/sec) were obtained. Other materials under investigation are the iron oxides and some ferrites, where, for trivalent iron, fields in the vicinity of 5.0×10^5 gauss were found. (auth)

14872 ON THE CONTRIBUTION OF THE FERMI CONTACT TERM TO THE MAGNETIC FIELD AT THE NUCLEUS. R. E. Watson (AVCO, RAD, Wilmington, Mass. and Massachusetts Inst. of Tech., Cambridge) and A. J. Freeman. J. Appl. Phys., 32: No. 3, Suppl., 118S-19S(Mar. 1961).

The dominant source of the effective magnetic field at the nuclei in ferromagnets apparently comes from the Fermi contact contribution of the s electrons in the core. This contribution was investigated for transition element atoms and ions by means of a series of spin polarized Hartree-Fock calculations. Calculations were done for both free-atom and crude crystalline environments. The sensitivity of the 3s electrons to 3d behavior was found to contribute to large differences in calculated effective fields. The differences between core polarizations in metals and ions are discussed with the use of a model for metallic iron (i.e., a $3d^8$ configuration) which is more consistent with neutron diffraction and energy band results than the free atom $3d^6$ state (the spin polarized $3d^8$ calculation shows an expanded 3d charge density but an almost unchanged spin density relative to the $3d^6$ results). The resultant (negative) increase in the effective field is not, however, large enough to overcome the positive contributions of the outer electrons so that although a net negative field is found it is not large enough in magnitude to agree with the Mössbauer measurements. A parallel calculation by Goodings and Heine, based on an artificially expanded 3d charge and spin densities, is also found to be similarly deficient. Their model is discussed and shown to be incompatible with neutron experiments and energy band calculations. (auth)

14873 NUCLEAR MAGNETIC RESONANCE OF Fe^{57} IN UNENRICHED Fe. J. I. Budnick, L. J. Bruner, R. J. Blume, and E. L. Boyd (Columbia Univ., New York). J. Appl. Phys., 32: No. 3, Suppl., 120S-1S(Mar. 1961).

The nuclear magnetic resonance of Fe^{57} was observed in iron specimens in the form of powders of various sizes, foils, and whiskers. It was found that the resonant frequency varies slightly among nominally pure iron specimens taken from different sources, suggesting that it is somewhat sensitive to impurity content. Prestrain of the specimen has a marked effect, the resonance in cold-rolled foil being very broad and weak compared to that observed in annealed foils. Observations of nuclear magnetic resonance in iron whiskers oriented both axially and transversely in the rf coil offer interesting confirmation of the domain wall enhancement mechanism put forth by Gossard and Portis. The temperature dependence of the Fe^{57} resonance was investigated in the range 77° to 785°K. (auth)

14874 NUCLEAR RESONANCES IN CUBIC, HEXAGONAL, AND MIXED PHASE COBALT POWDERS AND THIN FILMS. Wilton A. Hardy (IBM Labs., Owego N. Y.). J. Appl. Phys., 32: No. 3, Suppl., 122S-3S(Mar. 1961).

A number of nuclear resonances in ferromagnetic cobalt are reported and identified as originating in hcp crystallographic structure and in associated fault structure. A tentative assignment of these lines was made to possible stacking fault symmetries by correlating the observed resonances with metallurgical sample treatments. (auth)

14875 TRANSIENT EXCITATION OF NUCLEI IN FERROMAGNETIC METALS. M. Weger, E. L. Hahn and A. M. Portis (Univ. of California, Berkeley). J. Appl. Phys., 32: No. 3, Suppl., 124S-5S(Mar. 1961).

Free precession signals and spin echoes were observed from Fe^{57}, Co^{59}, and Ni^{61} nuclei in finely divided multidomain iron, cobalt, and nickel, respectively. Spin-lattice relaxation was studied in all three metals from temperatures in the liquid helium range to room temperature or above. Although the relaxation is not strictly exponential, the rate of recovery of the magnetization appears to be proportional to the absolute temperature. Spin-spin relaxation was studied in natural cobalt and in both natural and enriched samples of iron and nickel. The spin-spin coupling is very much stronger in cobalt than in iron or nickel, as expected, because of the very much larger nuclear magnetic moment of Co^{59}. Spin diffusion through the frequency spectrum of cobalt was investigated at 4.2 and 77°K by the simulated echo technique. The results are consistent with a theory of one-dimensional diffusion with exchange rate and exchange distance of the order of $1/T_2$ The spin-echo technique was used in all three metals to study the effect of domain wall motion on the nuclear resonance. A dc pulse, which displaces the domain walls by a controllable amount, is placed between the first rf pulse and the echo. This study confirms that the induction signals arise from nuclei in domain walls and further suggests a connection between line broadening and domain wall processes. A weak free-precession signal, arising from domain rotation, was observed from cobalt in high magnetic fields. The sign of the precession was determined, confirming that the hyperfine field is directed opposite to the magnetization. (auth)

14876 PARAMAGNETISM OF POLYCRYSTALLINE GADOLINIUM, TERBIUM, AND DYSPROSIUM METALS. Sigurds Arajs and R. V. Colvin (U. S. Steel Corp. Research Center, Monroeville, Penna.). J. Appl. Phys., 32: No. 3, Suppl., 336S-7S(Mar. 1961).

The paramagnetic susceptibilities of polycrystalline gadolinium, terbium, and dysprosium metals were studied between 300 to 1500°K. The measurements are in good agreement with predictions which use the localized *f*-electron model of interacting rare-earth ions and the Van Vleck theory of paramagnetism. Departures from the Van Vleck theory are attributed to paramagnetism of conduction electrons. An approximate value of this contribution was calculated for dysprosium. (auth)

14877 MAGNETIC MOMENTS OF COMPOUNDS OF COBALT WITH RARE-EARTH ELEMENTS HAVING A Cu_5Ca STRUCTURE. E. A. Nesbitt, H. J. Williams, J. H. Wernick, and R. C. Sherwood (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 32: No. 3, Suppl., 342S-3S (Mar. 1961).

Recently, the compound Co_5Gd was shown to have antiferromagnetic coupling. The present work is on compounds of this type in which most of the rare earth elements were substituted for gadolinium and copper was substituted for some of the cobalt. The rare earth elements which have a high magnetic moment (gadolinium, terbium, dysprosium, holmium, erbium, thulium) have an effect on the magnetization vs temperature curve which is startling. The moment is greatly reduced in the vicinity of 0°K in the presence of one of these elements, in contrast to the high moment obtained when yttrium or a low-moment rare earth element (cerium, praseodymium, neodymium, samarium) is present. As a result of these measurement, the magnetic structure of most of the compounds of cobalt with a rare earth element may be thought of as consisting of a sublattice of the rare earth with a magnetic moment in opposition to that of the sublattice of the cobalt atoms. All of the compounds conform to this picture with reasonable accuracy except those which contain praseodymium and neodymium. In these two cases, the moment of the compounds is actually increased but the reason for this behavior was not determined. The presence of compensation points in the magnetization of some of these materials was demonstrated experimentally. (auth)

14878 A STUDY OF THE MAGNETOHYDRODYNAMIC BOUNDARY LAYER ON A FLAT PLATE. M. B. Glauert (Univ. of Manchester, Eng.). J. Fluid Mech., 10: 276-88 (Mar. 1961).

The boundary layer on a semi-infinite flat plate in a uni-

form stream of conducting fluid, with a magnetic field in the stream direction such that the Alfvén speed is less than the undisturbed fluid speed, is discussed. Series solutions are derived which are applicable for large and small values of the electrical conductivity, and which give a guide as to the validity and limitations of theories which assume the fluid to have infinite or zero conductivity. (auth)

14879 QUANTIZATION OF FIELDS WITH INFINITE-DIMENSIONAL INVARIANCE GROUPS. Bryce S. DeWitt (Univ. of North Carolina, Chapel Hill). J. Math. Phys., 2: 151-62(Mar.-Apr. 1961).

A general approach to the problems of quantizing fields which have infinite-dimensional invariance groups is given. Space and time are treated on a completely equal footing. A Poisson bracket is defined by means of Green's functions, independently of the discovery or recognition of canonical variables, and is shown to satisfy all the usual identities. In accordance with the measurement theoretical foundations of the quantum theory, the Poisson bracket (i.e., commutator) is defined only for physically measurable group invariants. The Green's functions give a direct description of the propagation of small disturbances arising from a pair of mutually interfering measurements. In order to establish a correspondence between this approach and conventional canonical theory, a motivation for the adopted definition of the Poisson bracket is outlined with the aid of the fundamental theorem of canonical transformation theory. The rest of the discussion is logically independent of this, however. The general theory of "wave operators" and their associated Green's functions is briefly reviewed. Specific details connected with the group theoretical side of the theory are handled in such a way that problems of constraints are completely avoided. In the last section the general method is applied to the Yang-Mills field, as a nontrivial example. The problem of factor ordering is not studied. (auth)

14880 GENERALIZED RETARDED FUNCTIONS AND ANALYTIC FUNCTION IN MOMENTUM SPACE IN QUANTUM FIELD THEORY. Huzihiro Araki (Univ. of Illinois, Urbana). J. Math. Phys., 2: 163-77(Mar.-Apr. 1961).

The analytic n-point function in momentum space in quantum field theory is studied. Its different boundary values for real values of the argument are determined, and a necessary and sufficient condition for them to be obtainable from the Wightman functions is given. The conditions are relativistic covariance, support properties in coordinate space (retardedness), two-term identities for momentum below threshold (corresponding to spectrum conditions) and four-term identities (Steinmann relations). The first three conditions are translatable into a statement about the domain of analyticity of the n-point function: it is analytic in a union of various extended tubes plus the points of contact of two neighboring tubes for real part of one momentum below threshold. (auth)

14881 DETERMINATION OF THERMODYNAMIC GREEN'S FUNCTIONS. Gordon Baym and N. David Mermin (Harvard Univ., Cambridge, Mass.). J. Math. Phys., 2: 232-4(Mar.-Apr. 1961).

In the study of thermodynamic correlation functions or Green's functions, one is naturally led to a calculation of values of the Fourier transform of the Green's function on a discrete set of points in the complex energy plane. It is shown that even though these points do not in general possess a limit point within the region of analyticity, one may still uniquely determine the Fourier transform of the Green's function directly from its values at these points. (auth)

14882 ALMOST PERIODICITY AND THE QUANTAL H THEOREM. Ian C. Percival (University Coll., London). J. Math. Phys., 2: 235-9(Mar.-Apr. 1961).

The H theorem for an ensemble of isolated quantal systems with a discrete energy spectrum is false provided the systems satisfy certain broad conditions: the theorem is false for bounded many-particle systems with potential interaction, provided that interaction contains no repulsive singlarities stronger than r^{-2} and no attractive singularities stronger than r^{-1}. Ensembles of such systems behave almost periodically, in the sense of H. Bohr. The entropy and the probability of finding an observable in a given range are both almost periodic functions of time. (auth)

14883 LOWER BOUNDS AND ISOPERIMETRIC INEQUALITIES FOR EIGENVALUES OF THE SCHRÖDINGER EQUATION. Joseph B. Keller (New York Univ., New York). J. Math. Phys., 2: 262-66(Mar.-Apr. 1961).

The potential which minimizes the lowest eigenvalue of the one-dimensional Schrödinger equation is determined among all potentials V for which the integral of V^n has the prescribed value k. For each value of n and k this potential is found to be a special case of the Epstein-Eckart potentials which were originally introduced because the Schrödinger equation for them could be solved explicitly. The minimum eigenvalue is determined and it provides a lower bound on the lowest eigenvalue of any potential for which $\int V^n dx = k$. The expression of this fact as an inequality yields an isoperimetric inequality. For an arbitrary potential, each value of n provides one lower bound on the lowest eigenvalue, the largest of which is the best. This best bound is determined for the square well, the exponential, and the inverse power potentials. In the case of the square well, it is compared with the exact value. In the limiting case n = 1 the result reduces to that previously obtained by Larry Spruch, who showed that the delta function has the minimum lowest eigenvalue among all potentials of given "area." (auth)

14884 ON THE VIBRATION SPECTRUM OF A DISORDERED LINEAR LATTICE. [PART] I. J. Mahanty (Univ. of Maryland, College Park). Nuovo cimento (10), 19: 46-52(Jan. 1, 1961). (In English)

The average eigenfrequency equation of a disordered two-component linear chain is derived by a direct algebraic method. It is shown that the moments of the frequency spectrum can be evaluated from this equation. (auth)

14885 ELASTIC CONSTANTS OF AMMONIUM DIHYDROGEN PHOSPHATE (ADP) AND THE LAVAL THEORY OF CRYSTAL ELASTICITY. Hans Jaffe (Clevite Corp., Cleveland) and Charles S. Smith. Phys. Rev., 121: 1604-7(Mar. 15, 1961).

The acoustic shear wave velocities v_{yz} and v_{zy} were measured in ADP by the direct method of piezoelectric resonances, and by the direct pulse-echo method. These velocities are found with each method to be equal within the experimental uncertainty. The resonance results have a probable error of 0.1% for the difference between the corresponding Laval elastic constants c_{44} and c_{77}. This experimental result disagrees with those previously obtained with ADP by indirect methods. (auth)

14886 ELECTRICAL RESISTIVITY OF LANTHANUM, PRASEODYMIUM, NEODYMIUM, AND SAMARIUM. J. K. Alstad, R. V. Colvin, S. Legvold, and F. H. Spedding (Ames Lab., Ames Iowa). Phys. Rev., 121: 1637-9(Mar. 15, 1961). (IS-206)

The electrical resistivities of polycrystalline samples of La, Pr, Nd, and Sm are reported in the temperature range 1.3 to 300°K. La exhibits a superconducting transition at 5.8°K. The curve for Pr has slope changes at 61 and 95°K. The Nd curve shows small jumps at 5 and 20°K. Sm shows slope changes at 14 and 106°K. (auth)

14887 VISIBLE LUMINESCENCE OF RARE-EARTH YTTRIUM GALLIUM GARNETS. S. P. Keller and G. D. Pettit (IBM Research Center, Yorktown Heights, N. Y.). Phys. Rev., 121: 1639-48(Mar. 15, 1961).

Yttrium gallium garnet ($Y_3Ga_5O_{12}$) was prepared with small percentages of different rare earths substituted for yttrium. Garnets activated with Pr, Sm, Eu, Tb, Dy, Ho, Er, and Tm are all luminescent. The emission and excitation spectra of the samples were measured at 77°K. The data were analyzed in terms of the atomic energy levels of the impurity ions and the effects of crystalline field and of phonon interactions. Wherever possible, comments are made about whether the crystal field can be treated as possessing cubic or lower symmetry. (auth)

14888 OBSERVATIONS OF ELECTRON-HOLE CURRENT PINCHING IN INDIUM ANTIMONIDE. M. Glicksman and R. A. Powlus (RCA Labs., Princeton, N. J.). Phys. Rev., 121: 1659-61 (Mar. 15, 1961).

The temporal variation at high electric fields of the current and voltage in n-type InSb is examined. The observations show the behavior characteristic of self-pinching of the electron-hole plasma current. There is good agreement with theory for the observed times for the pinching process as a function of current. The calculated sum of the average energies of the electrons and holes in the plasma is 0.037 ev. Oscillations in the electric field of apparently different character are observed during the pinch, and when a longitudinal magnetic field is applied. (auth)

14889 ISOTOPE SHIFTS IN PALLADIUM. R. H. Hughes and F. A. Sharpton (Univ. of Arkansas, Fayetteville). Phys. Rev., 121: 1702-3(Mar. 15, 1961).

Isotope shifts in the $4d^95s\ ^1D_2-4d^95p\ ^3F_3^0$ transition at λ4212 A in the first spectrum of Pd were studied with the use of enriched isotopes. The shifts are similar to those found by Kuhn and Warner in the $4d^95s\ ^3D_3-4D^95p\ ^3F_4^0$ transition at λ3405 A. The most interesting feature is the maximum in the isotope shift which appears at the neutron number pair 60–58. (auth)

14890 ISOTOPE SHIFT IN THE ARC SPECTRUM OF NICKEL. Daniel J. Schroeder and J. E. Mack (Univ. of Wisconsin, Madison). Phys. Rev., 121: 1726-31(Mar. 15, 1961).

The isotope shift in 31 spectral lines in the nickel arc spectrum was determined by the use of a Fabry-Perot interferometer. The normal mass shifts were calculated ($\approx+0.025$ cm^{-1} between Ni^{58} and Ni^{64}) and subtracted from the observed isotope shifts. The differences were attributed to the specific mass and field effects. The relative shifts of levels of four configurations were deduced from the observed line shifts, these being the "complex" configurations $3d^84s^2$ and $3d^84s4p$ and the two-electron configurations $3d^94s$ and $3d^94p$. It was shown that the shifts due to the specific mass effect are a significant part of the observed shifts. Perturbations due to interconfiguration interactions were postulated to explain some of the observed shifts. The isotope shift to be expected between Ni^{58} and Ni^{64} on the basis of field effect calculations is about -0.02 cm^{-1} for a single 4s electron, while the shifts observed are as large as $+0.190$ cm^{-1}. A large fraction of this shift must therefore be attributed to the specific mass effect. By noting the deviations of the relative shifts between adjacent pairs of even isotopes from those predicted by mass effect theory, it was possible to deduce the relative field effect. The relative level shift resulting from the field effect is nearly the same for the adjacent isotope pairs 60-62 and 62-64 while the relative level shift for the isotope pair 58-60 is approximately 0.004 cm^{-1} larger than that for the other adjacent isotope pairs. The arrangement of neutrons in the outermost nuclear shells is believed to account for this difference. Within the experimental error the level shift of the Ni^{61} relative to the neighboring even isotopes is such that there is no odd-even staggering of the levels. (auth)

14891 CRYSTAL STRUCTURE OF THE β FORM OF He^4. R. L. Mills and A. F. Schuch (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 6: No. 6, 263-4 (Mar. 15, 1961).

An x-ray-diffraction study of solid He^4 at (15.45 to 16.15°K and 18,440 psi) is made, in an attempt to detect the presence of a cubic (β) crystal structure. The apparatus, sample preparation, and crystal analysis are described. The face-centered cubic phase is detected with a unit cell edge length of 4.240 ± 0.016A. (T.F.H.)

14892 NEW SOLID PHASE IN He^4. James H. Vignos and Henry A. Fairbank (Yale Univ., New Haven). Phys. Rev. Letters, 6: No. 6, 265-7(Mar. 15, 1961).

A new solid phase (γ) is found in He^4 between 1.45 and 1.78°K; this γ phase is detected and measured by sound velocity calculations, using the ultrasonic pulse technique at a carrier frequency of 10 Mc. The γ phase, which has about a 0.3% larger molar volume than the α phase, has a sound velocity of 520 to 545 m/sec, while the sound velocity in the α phase is 478 m/sec. It is suggested by analogy with He^3 that the γ phase is body centered cubic. (T.F.H.)

14893 QUANTUM STATISTICAL DERIVATION OF THE MACROSCOPIC MAXWELL EQUATIONS. K. Schram (Rijksuniversiteit, Utrecht). Physica, 26: 1080-90(Dec. 1960). (In English)

The macroscopic Maxwell equations in matter are derived on a quantum statistical basis from the microscopic equations for the field operators. Both the density operator formalism and the Wigner distribution function method are discussed. By both methods it can be proved that the quantum statistical ensemble averages of the microscopic electric and magnetic fields fulfill the usual macroscopic Maxwell equations. (auth)

14894 ON PHASE-SEPARATION IN AN ISOTOPIC MIXTURE OF HARD SPHERE BOSE AND FERMI GAS. E. G. D. Cohen and J. M. J. van Leeuwen (Universiteit, Amsterdam). Physics, 26: 1171-3(Dec. 1960). (In English)

The pseudo-potential method for a simple gas of hard spheres is applied to calculate the energy levels of an isotopic mixture of two hard-sphere gases. One of the gases obeys Bose-Einstein statistics; the other obeys Fermi-Dirac statistics. The free energy of the system is found from the energy levels through the partition function. The lambda and critical temperatures are found as functions of free energy and density, and the results are applied to mixtures of He^3 and He^4. (T.F.H.)

14895 ABSENCE OF DISPERSIVE PROPERTIES OF SPACE FOR ELECTROMAGNETIC RADIATION TESTED TO = 14×10^{-5}; COMMENTS ON A PROPOSAL OF SOFTKY AND SQUIRE. Jesse W. M. DuMond (California Inst. of Tech., Pasadena). Proc. Natl. Acad. Sci. U. S., 47: 347-8 (Mar. 1961).

A proposal to study the dependence of the velocity of light on frequency by detonating a nuclear device in space is discussed. It is stated that such a test already exists in measurements made with a bent quartz crystal diffraction spectrometer of the wavelength of the annihilation radiation generated in a block of copper by positrons from Cu^{64}. (T.R.H.)

14896 NEW METHOD FOR MEASURING SPUTTERING IN THE REGION NEAR THRESHOLD. Daniel McKeown

(Convair Astronautics Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instr., 32: 133-6(Feb. 1961).

A new method is described by which a plated quartz crystal oscillator is used for the measurement of sputtering. The crystal was placed in a molecular beam and sputtering of its plating was measured by the frequency change of the oscillator. The relation between the frequency change of the oscillator and the change in plating mass of the crystal is given. The method is extremely sensitive. Sputtering of less than a millimicrogram of plating can be measured. A wide range of material can be used to plate the crystal. A crystal oscillator sputtering gage was built by using a frequency counter with a digital readout to record the oscillator frequency. The operation of the gage is illustrated by preliminary measurements on the sputtering rates of gold in an argon beam between 0 and 100 ev. Other uses of the gage, such as a neutral beam detector, are also discussed. (auth)

14897 PULSE CONDUCTION IN DECAYING PLASMA. V. Arunasalam and John D. Trimmer (Univ. of Massachusetts, Amherst). Rev. Sci. Instr., 32: 282-5(Mar. 1961).

Apparatus was constructed in which plasma, ionized by 144-Mc radiofrequency excitation, is subjected to repeated submicrosecond voltage pulses immediately after excitation is removed. It is expected that observed variation of resulting current pulses may be correlated with quantitative aspects of the plasma decay. (auth)

14898 X-RAY MASS ABSORPTION COEFFICIENTS FOR Mo, Nb, Zr AND Ti. W. R. Sweeney, R. T. Seal, and L. S. Birks (U. S. Naval Research Lab., Washington, D. C.). Spectrochim. Acta, 17: 364-5(Mar. 1961). (In English)

Experimental determinations of the absorption coefficients for Mo, Nb, Zr, and Ti were made in the 0.5 to 1.5 A range. Values are accurate to about 1%. A modified commercial fluorescent x-ray spectrometer was used for the measurements. Precautions were taken to insure monochromatic incident radiation at each wavelength. (N.W.R.)

14899 THE ALTERNATING CURRENT RESISTANCE OF AN ELECTRIC ARC. Wolfgang Frie (Siemens-Schuckertwerke A. G., Erlangen, Ger.). Z. angew. Phys., 13: 99-102(Feb. 1961). (In German)

A formula for the complex resistance operator was derived from the theory of the wall-stabilized arc by H. Maecker. It includes, for each point of the current-voltage curve, the limiting cases of very large and very small frequencies. The results are compiled in a position-curve diagram. (tr-auth)

14900 EFFECT OF THE DEGREE OF POLYMERIZATION ON THE LIGHT YIELD AND THE ENERGY OUTPUT IN ARTIFICIAL SCINTILLATORS. H. Heusinger (Technische Hochschule, Munich). Z. Naturforsch, 15a: 1068-72 (Dec. 1960). (In German)

Polystyrol and polyvinyl acetate samples with degrees of polymerization from 100 up to 10,000 were mixed with solutions of organic phosphors such as p-terphenyl or 2,5-diphenyloxazol, and the luminescence of the foils produced by vaporization of the solution was excited with Sr^{90} β radiation. The luminescence yield was measured in dependence on the degree of polymerization and the phosphor concentration. Polystyrol foils gave significantly better light yields than polyvinyl acetate foils. Furthermore, an increase of the luminescence yield was observed with increasing degree of polymerization with especially sharp increase up to the phosphor concentration in which one phosphor molecule meets with one polymer molecule. The experimental results were explained as an energy transfer chiefly over the polymer chain. (tr-auth)

14901 MULTIPLE SCATTERING OF 8-MEV α PARTICLES ON LEAD. Hans Fleischmann (Technische Hochschule, Munich). Z. Naturforsch, 15a: 1096-1100(Dec. 1960). (In German)

Scattering experiments of the α radiation from ThC and ThC' on lead foils of 10.93 mg/cm^2 show agreement with the Moliere theory within a measurement accuracy of 2.5% for the Moliere parameter B, i.e., about 7% for the screening angle χ_a. At a mean impact number $\Omega = 29$, corresponding to 2.6 mg/cm^2 lead, a value for B, increased about 7 ± 3%, results which agrees well with the deviation to be expected on the basis of the approximation assumptions on the single cross section. (tr-auth)

14902 EFFECTS OF α IRRADIATION ON ZINC SULFIDE PHOSPHORS. N. Riehl, R. Sizmann, and O. J. Stadler (Technische Hochschule, Munich). Z. Naturforsch., 16a: 13-20(Jan. 1961). (In German)

The variations in the glow curve and the luminescence spectrum of ZnS and ZnO phosphors after α irradiation were investigated. After the irradiation no new glow curves were found. Possibly deep traps produced by irradiation participated only as quenching centers. The Zn and S defects formed in the phosphor by irradiation were calculated. After irradiation of green-luminescent ZnS(Cu) phosphors, a blue emission band was prominent. This effect was traced back to the origin of blue-luminescent Zn^{2+} defects. (tr-auth)

14903 ENERGY DISTRIBUTION OF ARGON AND HYDROGEN IONS FROM A HIGH FREQUENCY ION SOURCE. Horst Löb (Universitat, Giessen, Ger.). Z. Naturforsch., 16a: 67-75(Jan. 1961). (In German)

The energy distribution of Ar^+, H^+, H_2^+, and H_3^+ ions, after mass separation, was measured and interpretated. In the energy spectra, up to eight different peaks occur. Height, energy, width, and time modulation of the energy peaks were investigated in dependence on the operating parameters. Both peaks with the greatest extraction energy were formed from plasma ions. Two other peaks originate in the upper part of the space-charge range chiefly ion charge reversal. The splitting of the plasma and the space-charge peaks results from high-frequency oscillations of the plasma boundary. This also means a temporal ion current modulation. Two secondary peaks originate from secondary electron collisions in the lower park of the space-charge range. Both low-energy peaks are formed by ion charge reversal in or under the extraction channel. (tr-auth)

14904 THE TRANSLATIONAL INVARIANT OSCILLATOR POTENTIAL. Gerhart Lüders (Universität, Gottingen, Ger.). Z. Naturforsch., 16a: 76-8(Jan. 1961). (In German)

The quantum mechanical problem is discussed of A identical particles moving in a translationally invariant oscillator potential. Use is made of the close connection of this problem with the one where the potential is fixed in space. In particular, relations are given between the number of states of prescribed permutational symmetry (and orbital angular momentum) and of fixed energy, in the two problems. (auth)

14905 THE SINGULARITY OF THE SOLUTION OF THE MAGNETOHYDRODYNAMIC BOUNDARY VALUE PROBLEM. Cs. Hargitai and J. Szabo (Univ. of Budapest). Z. Naturforsch., 16a: 92-4(Jan. 1961). (In German)

The singularity of the solution of the magnetohydrodynamic basic equation was indicated. It was assumed that the conducting viscous liquid is incompressible and the region containing the liquid is limited with a smooth sur-

face whose points are all finite. A further assumption is that the magnetic field strength, the velocity, and the pressure in the total current region have constant partial leakage. If the values of the magnetohydrodynamic magnitudes for $t > 0$ at the boundary surface but for $t = 0$ in the complete range are given by continuous functions, then the solution of the basic equation of magnetohydrodynamics is singular. (tr-auth)

14906 THE POTASSIUM CONTENT OF CHONDRITES, ACHONDRITES, AND SIDERITES. H. Wänke (Max-Planck-Institüt für Chemie, Mainz). Z. Naturforsch., 16a: 127-31 (Jan. 1961). (In German)

The potassium concentration in various meteorites was determined by means of the neutron activation with the reaction $K^{41}(n,\gamma)K^{42}$. The high sensitivity of the method permits, in addition to the determination of the potassium content of chondrites, the measurement of the very small potassium contents in some achondrites. The very low potassium content of some iron meteorites could be measured with sufficient accuracy. Whereas in the stone meteorites the total potassium concentration could be calculated easily from the measured K^{41} mass on the basis of the frequency of the 41 isotope (6.8%), such an indication of the total potassium concentration in some iron meteorites was not possible since the measured K^{41} mass was so low that it must be assumed that considerable masses or almost all the K^{41} arose on the basis of the effect of cosmic radiation on the iron core of the meteorite. The values obtained were interpretated as the limiting value for the K^{41} produced by cosmic radiation. (tr-auth)

14907 MEASUREMENTS ON THE RANGE OF 20.4-MEV ELECTRONS. G. Harigel, M. Scheer, and K. Schultze (Max-Planck-Institut für Physik and Astrophysik, Munich). Z. Naturforsch., 16a: 132(Jan. 1961). (In German)

The path length, projected range, and the actual range in Freon (CF_3Br, density 1.5 g/cm^3) were measured for electrons with an initial energy of 20.4 Mev. The electrons entered a 0.5-l cloud chamber and came to rest there. The path-length distribution observed is given and compared with the theoretical distribution. The experimental results agree with the theoretical curve which takes into consideration both the ionization and radiation. To about a third of the electrons with path length smaller than 6 cm, a Compton electron or electron pair can be correlated within the cloud chamber. This is an indication of a large energy loss through the production of energy-rich x-ray quanta. (J.S.R.)

14908 THE TIME PATTERN OF THE CURRENT OF A GAS DISCHARGE IN HYDROGEN. R. Kluckow (Universität, Hamburg). Z. Physik, 161: 353-69(1961). (In German)

The transient growth of currents in a Townsend gas discharge system under uniform d-c field conditions in hydrogen is examined. The discharge is started by 10^3 to 10^6 electrons released from the cathode by an u-v light pulse within some 10^{-7} seconds. Observed oscillations of the current are found to be due to the motion of the electrons through the gap, creating new electrons by photoelectron emission at the cathode by photons generated in the gap. At sparking threshold conditions ($\mu_0 = 1$) the electron current becomes self-sustaining after a few electron transit times. The positive ion current soon exceeds the electron current and grows linearly with time ($\mu_0 = 1$) until the positive ions of the first generation enter the cathode. For times greater than a positive-ion transit time the current becomes self-sustaining. Neglecting space-charge effects, one would not expect a spark to occur. The space-charge of the positive ions, however, causes a distortion of the field changing the ionization efficiency of the electrons. It is shown that an observed rapid growth of current leading to breakdown after some positive-ion transit times is in agreement to this conception. (auth)

14909 OPERATOR RANGE TRANSFORMATION IN QUANTUM ELECTRODYNAMICS. Horst Rollnik (Universität, Heidelberg, Ger.). Z. Physik, 161: 370-9(1961). (In German)

The formulation of operator range transformations is discussed. By using some simple consequences of charge conservation and the equal time commutation relations, it is possible to give an exact meaning to a certain class of such transformations. This class contains all the special cases which have obtained importance for practical calculations. Only renormalized Heisenberg operators are used throughout. (auth)

14910 THE COUPLING MECHANISM BETWEEN LONGITUDINAL AND TRANSVERSE WAVES IN A PLASMA. G. Burkhardt, Ch. Fahl, and R. W. Larenz (Technische Hochschule, Hanover). Z. Physik, 161: 380-7(1961). (In German)

Since electron plasma oscillations are assumed to cause nonthermal cosmic radiofrequency radiation, the problem of coupling between longitudinal and transversal plasma waves becomes important. Starting from the basic plasma equations, all possible coupling mechanisms are deduced in a general way. Besides the hitherto known mechanisms such as the effect of a pressure gradient of an external magnetic field, and of a general flow or drift field, a new nonlinear "internal coupling" effect which is able to generate electromagnetic radiation is shown to exist. Finally some remarks concerning the relativistic aspect of the problem are added, as errors are found in the literature. (auth)

14911 SPECTRUM, ZEEMAN EFFECT, AND ELECTRON TERMS OF TRIVALENT ERBIUM IN CRYSTALLINE SALTS. III. TERM SCHEME AND EIGENSTATES OF THE Er^{3+} ION. H. G. Kahle (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 161: 486-95(1961). (In German)

The terms of Er^{3+} ions were calculated by diagonalization of the complete matrix of the Coulomb repulsion of the electrons and of the spin-orbit interaction for the configuration f^{11}. The optimum values of the constants were determined by comparison with the term position determined spectroscopically in crystalline salts. There is complete agreement between experiment and theory for the J values. The intermixture of the Russell-Saunders terms as a result of the spin-orbit coupling was quantitatively obtained. From the theoretical eigenstates, the Landé g factors were calculated, and the values agree very well with the experimental values. (tr-auth)

14912 DISSOCIATION AND CHARGE OF HYDROGEN AND DEUTERIUM MOLECULAR IONS IN PASSAGE THROUGH HYDROGEN. Albert Schmid (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 161: 550-9(1961). (In German)

In a beam of H_2^+ or D_2^+ ions passing through hydrogen the following secondary particles are produced by dissociation and charge exchange: H^+, H^0, and H_2^0 or D^+, D^0, and D_2^0. The cross sections q_1, q_2, and q_3 for the production of these particles were measured in the energy range from 15 to 95 kev. A proportional counter supplemented by an electrostatic field at its immediate entrance was used for detecting and discriminating the different particles. (auth)

14913 EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF THE ELECTROMAGNETIC FIELD ON THE STREAM-LINE OF CYLINDER. I. L. Kuznetsov (Kalinin

Leningrad Polytechnic Inst.). Zhur. Tekh. Fiz., 30: 1041-5(Sept. 1960). (In Russian)

Quantitative evaluation was made of data on the influence of an electromagnetic field on the streamline of a semi-cylinder and the effects of the shape of the electrodes on the magnitude of the effect. (R.V.J.)

14914 ROTATION OF A SPHERE IN A VISCOUS CONDUCTING FLUID IN A MAGNETIC FIELD. G. Z. Gershuni and E. M. Zhukhovitskii (Perm State Univ., Perm State Pedagogical Inst.). Zhur. Tekh. Fiz., 30: 1067-73(Sept. 1960). (In Russian)

The motion of a viscous incompressible conducting fluid near a uniformly rotating sphere in a magnetic field oriented along the axis of rotation was studied. A case of slow rotation where inertial forces are neglected as compared to viscous forces and the Reynolds' magnetic number is small was studied, and the velocities and induced field are found. Formulas are developed for the delaying moment. In weak fields the delaying moment increases proportionately to the square of the field, whereas in strong fields its dependence is linear. The problem of a slowly rotating sphere in a conducting fluid in a magnetic field was resolved previously by the method of approximations. The previously found solution holds good for the weak fields where the velocity distribution differs only slightly from that without any field. A general solution is derived which holds good for strong magnetic fields. (tr-auth)

14915 ON MAGNETOHYDRODYNAMICS OF STREAMLINING MAGNETIC FIELD SOURCES BY IDEALLY CONDUCTING INCOMPRESSIBLE LIQUID. G. A. Grinberg (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 19-22(Jan. 1961). (In Russian)

General postulations are presented pertaining to the solution of the problem of the motion of a conducting fluid in tubes placed in a transverse magnetic field. It is shown that the solution can be reduced to one auxiliary function, satisfying a fourth-order equation with special derivatives. Moreover, in the case of nonconducting or ideally conducting walls, the corresponding boundary conditions have a relatively simple appearance. It is also shown that the problem can be reduced to one integral equation, which resolves the magnitudes either directly or in quadratures. (R.V.J.)

14916 MAGNETOHYDRODYNAMIC PROBLEM OF STREAMLINING MAGNETIC FIELD SOURCES BY IDEALLY CONDUCTING INCOMPRESSIBLE LIQUID. G. A. Grinberg (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 23-8(Jan. 1961). (In Russian)

A search was made for precise or approximate solutions to the two-dimensional problem of magnetic field streamlining in an ideally conducting liquid. (tr-auth)

14917 WAVES OF CURRENT IN A THIN CYLINDRIC CONDUCTOR. III. VARIATION METHOD AND ITS APPLICATION FOR THE THEORY OF IDEAL AND IMPEDANCE CONDUCTORS. L. A. Vaĭnshteĭn (Moscow Inst. of Problems in Physics). Zhur. Tekh. Fiz., 31: 29-44(Jan. 1961). (In Russian)

A sequence of approximations based on the variational principle was formulated. It is shown that even in the first approximation the suggested variational method gives a good (and sufficiently simple) approximation of the slowly changing functions for a conductor with a finite linear impedance. The variation method was also used for developing a simple approximation expression describing the scattering of a plane electromagnetic wave on the semi-finite conductors. (tr-auth)

14918 WAVES OF CURRENT IN A THIN CYLINDRIC CONDUCTOR. IV. ENTRANCE IMPEDANCE OF A VIBRATOR AND THE ACCURACY OF THE FORMULAS. L. A. Vaĭnshteĭn (Moscow Inst. of Problems in Physics). Zhur. Tekh. Fiz., 31: 45-50(Jan. 1961). (In Russian)

The incoming impedance parameter of an infinite conductor was determined, and the validity of this parameter in calculating the incoming impedance of a transmitting vibrator (thin direct conductor of finite length) was determined. (R.V.J.)

14919 CALCULATIONS OF THE a-c DISTRIBUTION ON THE SURFACE OF ROTATING BODIES AT STRONG SKIN EFFECT. G. A. Shneerson (Leningrad Polytechnic Inst.). Zhur. Tekh. Fiz., 31: 51-4(Jan. 1961). (In Russian)

The problem in a-c distribution on a toroidal surface with strong skin effect was previously resolved for the case where the condition $H_n = 0$ is fulfilled. A similar problem for a rotating, arbitrarily shaped object was reduced to an integral equation (similar to the electrostatic problem). (R.V.J.)

14920 THE DISTRIBUTION OF CENTIMETER WAVES THROUGH WAVEGUIDES FULL OF POSITIVE DISCHARGE PLASMA. [PART] I. V. E. Golant, A. P. Zhilinskii, M. V. Krivosheev, and G. P. Nekrutkina (Leningrad Polytechnical Inst.). Zhur. Tekh. Fiz., 31: 55-62(Jan. 1961). (In Russian)

The propagation of centimeter waves through waveguides filled with positive discharge plasma is analyzed for the case in which a weak high-frequency field does not influence the plasma. (R.V.J.)

14921 THE DISTRIBUTION OF CENTIMETER WAVES THROUGH WAVEGUIDES FULL OF POSITIVE DISCHARGE PLASMA. [PART] II. V. E. Golant, A. P. Zhilinskii, M. V. Krivosheev, and L. I. Chernova (Leningrad Polytechnical Inst.). Zhur. Tekh. Fiz., 31: 63-70(Jan. 1961). (In Russian)

An analysis was made of the nonlinear effects following centimeter wave propagation through a positive discharge plasma. The wave propagation constant was studied as a function of the high-frequency field voltage in the region of nonlinear effects. The obtained results are correlated with theoretical calculations. (R.V.J.)

14922 ON THE KINETIC THEORY OF REFLECTION OF ELECTROMAGNETIC WAVES FROM MOVING PLASMA. V. I. Kurilko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR, Kharkov). Zhur. Tekh. Fiz., 31: 71-7(Jan. 1961). (In Russian)

The coefficient of electromagnetic wave reflection from a moving plasma was calculated in the kinetic approximation at a stationary point. Kinetic and hydrodynamic approximation data are compared and analyzed. (R.V.J.)

14923 THERMOELECTRIC MATERIALS AND DEVICES. Irving B. Cadoff and Edward Miller, eds. Materials Technology Series. New York, Reinhold Publishing Corporation, 1960. 356p.

Lectures are compiled from a course on Thermoelectric Materials and Devices, offered by New York University in June 1959 and June 1960. The theory of thermoelectric processes and circuits is studied. The theoretical and experimental materials used as thermoelements are evaluated; materials currently used and those considered for future use are discussed. A study is made of device design; this study includes descriptions of some experimental and prototype units which have been built and evaluated. (T.F.H.)

Astrophysics and Cosmology

14924 (NP-9968) ASTRONAUTICS INFORMATION. OPEN LITERATURE SURVEY, VOLUME III, NO. 2 (EN-

TRIES 30,202–30,404). (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Feb. 1961. Contract NASw-6. 51p.

(For preceding period see NP-9863.)

14925 (NP-9973) TEMPERATURE CONTROL OF SATELLITE AND SPACE VEHICLES. An Annotated Bibliography. Robert C. Gex, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Feb. 1961. 32p. (SB-61-5)

An annotated list of references on temperature control of satellite and space vehicles is presented. Methods and systems for maintaining vehicles within tolerable temperature bounds while operating outside planetary atmospheres are outlined. Discussions of the temperature environment in space and how it might affect vehicle operation are given. Re-entry heating problems are not included. Among the sources used were: Engineering Index, Applied Science and Technology Index, Astronautics Abstracts, PAL uniterm index, ASTIA, and LMSD card catalog. (auth)

14926 ABUNDANCES IN G DWARF STARS. III. STARS IN MOVING CLUSTERS. H. L. Helfer (Univ. of Rochester, N. Y.), George Wallerstein, and J. L. Greenstein. Astrophys. J., 132: 553-64(Nov. 1960). (AFOSR-TN-60-763)

Abundance determinations were made for three G dwarf stars (one young, two old) that are members of some of Eggen's moving clusters. The metal abundance is roughly solar, but all three stars show a slight overabundance of barium and an underabundance of manganese. One star, HD 30455, appears to have a slight underabundance of those elements produced by the e-process, compared to those produced by the s-process. (auth)

14927 EQUATION OF A CHARGED PARTICLE SHELL IN A PERTURBED DIPOLE FIELD. Ralph H. Pennington (Headquarters, Defense Atomic Support Agency, Washington, D. C.). J. Geophys. Research 66: 709-12(Mar. 1961).

The earth's magnetic field is considered to be described as a dipole perturbed by the addition of higher-order poles of small magnitude. An equation is given for the shell generated by the motion of a trapped, charged particle. The equation obtained is shown to be in agreement with the shell measured by satellite 1958 ϵ following the high-altitude nuclear detonation of September 6, 1958. Magnetic field coefficients in various coordinate systems are given. (auth)

14928 STREAMING OF INTERSTELLAR HYDROGEN IN THE VICINITY OF THE SUN. R. X. McGee, J. D. Murray, and J. L. Pawsey (Commonwealth Scientific and Industrial Research Organization, Sydney). Nature, 189: 957-9(Mar. 25, 1961).

Observations were made of the 21-cm hydrogen line in an effort to determine the bulk movement of interstellar gas in our Galaxy. Observations were made over Sidney, Australia, with an aerial beam of 2.2° between half-power points and with a 48-channel H-line receiver at frequency intervals equivalent to 7 km/sec in radial velocity about the natural line frequency. An analysis of results led to the conclusion that at high latitudes neutral hydrogen is flowing in from above and below at ~6 km/sec. At low and middle latitudes the flow is away from the sun in the direction of the galactic center. It was not established that such a flow was part of a general circulation. If it is, the hydrogen involved is sufficient to make the phenomenon a major feature of galactic dynamics. (C.H.)

14929 MAGNETIC MIRRORS IN THE MILKY WAY GALAXY. L. Marshall (Brookhaven National Lab., Upton, N. Y.). Nuovo cimento (10), 19: 6-19(Jan. 1, 1961). (In English). (BNL-4833)

It is shown that the present day velocity distribution of the Milky Way galaxy amplifies the magnetic field in the galactic arms by stretching the existing lines of force in such a way as to produce magnetic mirrors in the regions between 4 and 10 kiloparsec radius. The strength of the mirrors is increasing with time so that, effectively, a mirror of given strength seems to be moving out along the arm. It is suggested that these mirrors, fixed at constant radius but effectively moving, are important in production of cosmic rays, and it is shown that the appropriate constants relating to the mirrors are compatible with a Fermi accelerator mechanism of first order dependence on effective mirror velocity. The energy for this process is derived from differential rotation energy of which there is an adequate supply. (auth)

Cosmic Radiation

14930 (AEC-tr-3972(p.205-89)) THE ORIGIN OF COSMIC RAYS. B. L. Ginzburg. Translated from Uspekhi Fiz. Nauk, 62: No. 2, 37-98(1957).

A theory of the origin of cosmic radiation based on radio-astronomical data is presented. The composition, energy spectra, and isotropy of primary cosmic radiation in the neighborhood of earth are discussed. The magnetic bremsstrahlung nature of cosmic radio-emission and the distribution of cosmic radiation in the galaxy are described. The motion of cosmic particles in interstellar space was considered. It was concluded that cosmic radiation originates in the expanding envelopes of supernovae and possible also of novae. A substantiation of this point of view is outlined. Other theories of the origin of cosmic rays are reviewed. (M.C.G.)

14931 (UCRL-Trans-610) DETECTION OF COSMIC RADIATION BY MEANS OF RADIATION-CHEMISTRY METHODS. J. Eugster. Translated by R. Lehman, R. Kingsbury, and M. J. Tunis from Radiol. Clin., 22: 130-9(Mar. 1953). 13p. (Includes original, 6p.)

Observations of the effects of cosmic rays on radiochemical reactions in dilute solutions of dyes and enzymes show that the methods cannot be considered in a form suitable for x-ray dosimetry. The methods can be useful for a qualitative detection of radiation, using the enzymes which are most sensitive to radiation. Experiments were conducted which indicated that Folin Phenol Reagent and triphenyltetrazolium chloride (red and blue) were sensitive to cosmic rays. The advantages of radiochemical detection of cosmic rays as compared to photographic detection are: fading is eliminated; a protracted exposure for biological investigations can be carried out better; the injection of the indicator in the living tissue can be distributed more homogeneously; and the ionizing factors of cosmic rays can be detected better, from which the effective cross section of the various radiation components can be calculated. (B.O.G.)

14932 SOLAR-PRODUCED COSMIC RADIATION NEAR THE GEOMAGNETIC POLE ON MAY 4, 1960. Martin A. Pomerantz and Vasant R. Potnis. J. Franklin Inst., 270: 227-31(Sept. 1960).

A preliminary description was given of a cosmic ray intensity increase at Thule, Greenland (geomagnetic latitude 88°N), on May 4, 1960. The intensity was above normal for about three hours; the peak intensity was 233 per cent of normal, and lasted about six minutes. Observations by the Thule station were correlated with observations of solar flares, radio noise, and with other cosmic ray monitoring stations. The cosmic radiation intensifications are found to correspond to the solar activity. (T.F.H.)

4933 COSMIC-RAY NEUTRON DEMOGRAPHY. W. N. lless (California Univ., Livermore), E. H. Canfield, and R. E. Lingenfelter. J. Geophys. Research, 66: 665-77(Mar. 1961).

The equilibrium spatial and energy distribution is calculated for neutrons made in the earth's atmosphere by cosmic rays. The neutron current leaking into space is found, and the density of neutron decays in the vicinity of the earth is computed for a future determination of importance as a source for the Van Allen belts. The spectrum and the leakage current below 10 Mev are determined from multigroup diffusion theory; the leakage above 10 Mev (<1 per cent of total) is approximated from geometrical arguments. An integrated source over each square centimeter of earth surface (at geomagnetic latitude 44°N) of 6.2 neutrons/sec (1.2 from 'knock-on' processes above 10 Mev and 5.0 from evaporation processes below 10 Mev) gives an equilibrium spectrum in agreement with the ±25 per cent accuracy of measured values. This source corresponds to a global average of 4.6 neutrons/cm^2/sec, of which 0.8 leak into space, 2.9 form C^{14}, and 0.9 is absorbed in other processes. Gravitationally trapped neutrons (<0.66 ev) amount to less than 1 per cent of the total leakage, but they contribute substantially to the decay density near the earth (e.g., 40 per cent of total decays at $\frac{1}{2}$ earth radius). (auth)

14934 SCINTILLATION-COUNTER OBSERVATIONS OF AURORAL X RAYS DURING THE GEOMAGNETIC STORM OF MAY 12, 1959. P. D. Bhavsar (Univ. of Minnesota, Minnesota). J. Geophys. Research, 66: 679-92 (Mar. 1961).

Auroral X rays were observed at 10 g/cm^2 atmospheric depth over Minneapolis on May 12, 1959, with a balloon-borne NaI scintillation spectrometer in the energy range 22 to 263 kev. This event accompanied the low-energy solar cosmic rays that also produce some γ rays in the atmosphere. Energy spectra of the X rays were obtained after correcting for the presence of these γ rays. The peak in the auroral X-ray intensity was found to be associated with the passage of the aurora at the zenith. The electron spectrum responsible for the X rays was determined and found to be in agreement with the observations of electron spectrum of the outer radiation belt. (auth)

14935 STUDY OF A HIGH-ENERGY NUCLEAR INTERACTION. György Bozóki, Gabor Domokos, Ervin Fenyves, Eva Gombosi, K. Lanius, and H. W. Meier. Magyar Tudományos Akad. Központi Fiz. Kutató Intézetenek Közleményei, 6: 105-16(1958). (In Hungarian)

In a cooperative effort of the Budapest and Berlin Scanner Groups, the nuclear plates exposed at the Po Valley expedition were carefully examined. On the basis of the angular distribution of the shower particles, using first approximation and maximum likelihood methods, the primary energy was found to be 1.3×10^{13} ev/nucleon. The angular distribution had a singularly non-isotropic character, agreeing well with values expected on the basis of Landau's and Heisenberg's theories. The shower particles could be followed to a distance of about 70 mm. Within this distance 3 secondary interactions were found, 2 of which were caused by charged and the third by a neutral particle. The angle of the cone of the 0 + 16 α primary jet was 10^{-3} radian containing 8 charged particles while the 10^{-1} diffusion cone contained 8 additional charged particles. The average energy of the π^0 mesons was estimated on the basis of the energy of the electron pairs. The energy spectrum of the shower particles did not agree too well with the theory but the small number of experimental data did not allow a rigorous statistical treatment. Determination of the relative scattering of the secondary particles is in progress. (TTT)

14936 THEORETICAL CALCULATION OF THE SOLAR DIURNAL VARIATION OF THE COSMIC RAY INTENSITY. K. Nagashima, V. R. Potnis, and M. A. Pomerantz (Franklin Inst., Swarthmore, Penna.). Nuovo cimento (10), 19: 292-330(Jan. 16, 1961). (In English)

The expected solar diurnal variation of the intensity of the nucleonic component of the cosmic radiation at sea level was calculated at various geomagnetic latitudes and longitudes for the cases in which the anisotropy is produced outside the terrestrial magnetic field (extra-terrestrial origin), and in which the anisotropy is produced inside the terrestrial magnetic field (terrestrial origin). In this calculation, the orientational difference between the earth's rotational and the geomagnetic dipole axes is considered. The expression for the anisotropy, Δf, contains three parameters, m, n, and P_t. The parameter, m, determines the rigidity dependence of Δf in the expression, $\Delta f \propto P^{-m}$. The parameter, n, determines the directional dependence of Δf in momentum space with respect to the plane parallel to the geomagnetic or geographic equator in the expression $\Delta f \propto (\cos\theta)^n$, where θ is the angle between the plane and the direction mentioned above. P_t is a definite value of rigidity, for rigidities smaller than which Δf is zero. This expression for the anisotropy could easily be utilized in terms of any description of the model of production of the anisotropy by the appropriate choice of these three parameters. It is also possible to determine the most suitable values of these parameters by the comparison of the calculated and observed diurnal variations. The geographic local time of the maximum intensity shows a geomagnetic longitudinal dependence for both terrestrial and extra-terrestrial origins. On the other hand, the amplitude shows a longitudinal dependence at latitudes higher than 50°, only for the extra-terrestrial origin. At latitudes lower than 50°, there is no significant difference between the diurnal variations expected from the terrestrial and extra-terrestrial origins. The altitude correction factors of the diurnal variation of the nucleonic component are obtained. These factors are nearly independent of the geomagnetic longitude of the observational station. (auth)

14937 COSMIC-RAY FLARE OF NOVEMBER 20, 1960. Richard T. Hansen (Univ. of Colorado, Boulder). Phys. Rev. Letters, 6: No. 6, 260-2(Mar. 15, 1961).

A solar flare was observed on November 20, 1960, from 1955 to 2032 U. T. This flare, which was responsible for a 2800 Mc noise burst and a cosmic neutron increase, was described, analyzed, and compared with a similar flare which occurred on May 4, 1960. The observations were made from Boulder, Colorado. (T.F.H.)

14938 A BURST OF COSMIC-RAY INTENSITY ON FEBRUARY 23, 1956 AND ITS INTERPRETATION. L. I. Dorman and G. I. Freidman. Trudy Yakutsk. Filiala Akad. Nauk S.S.S.R., No. 2, 129-69(1958).

Experimental data on the burst of cosmic ray intensity which took place on February 23, 1956, are systematized and studied. The data from 37 stations located in geomagnetic latitudes from 83 n.lat. to 73°s.lat. are processed. The distribution of the burst effect over the globe at different instants from $3^h 50^m$ to $0^h 00^m$ universal time is investigated. In the first period of the burst a sharp anisotropy is observed with an additional flux of particles from the sun; half-an-hour later, the flux of solar particles is "broadened" and approximates an isotropic one. The energy spectrum of solar particles is found for individual time

instants. The results are interpreted and the possibility of generation of relativistic particles on the sun is discussed according to the following hypothesis: acceleration of particles on the sun in the chromospheric flare is mainly brought about by a statistic mechanism on account of the energy of magnetic fields and kinetic motions in the flare. Only in the first moment a more rapid acceleration mechanism should be in operation, similar to acceleration of particles in the pinch-effect. The mean life time of particles in a flare is 10^2 sec, the range for scattering $\gtrsim 2 \times 10^7$ cm, and disorderly speed of magnetic field heterogeneities $\gtrsim 3 \times 10^7$ cm/sec. Going beyond the limits of a chromospheric flare, accelerated particles diffuse in the "supercorona" of the sun with the mean life time of $\sim 10^3$ sec and the mean scattering range of $\gtrsim 10^{12}$ cm. The dimensions of the corona then proved to be $\gtrsim 7 \times 10^{12}$ cm. The particles abandon the "supercorona" symmetrically to all sides. A fraction of the particles, moving along a straight line, hit the earth immediately after the ejection (anisotropic flux in the first period after the flare beginning. The rest of the particles, ejected along other directions than to the earth, may hit the earth only after scattering in the interplanetary space by the magnetized clouds, corpuscular fluxes with frozen-in magnetic fields, or by other formations. The problem of injecting the particles and energy losses is discussed. Relativistic electrons should be absent in the fluxes of solar cosmic rays. (TCO)

Criticality Studies

14939 CRITICALITY ESTIMATES FOR SPHERES AND SLABS. T. W. Mullikin (RAND Corp., Santa Monica, Calif.). Proc. Natl. Acad. Sci. U. S., 47: 349-51(Mar. 1961).

In neutron transport theory, determination of the critical mass of a reactor is reduced to determining the spectral radius of a linear integral operator T. The operator T is obtained by a transformation from the steady-state transport equation to an integral equation for the neutron flux. At one point in this transformation, T is represented as an integral of a one-parameter family of compact self-adjoint operators whose spectral resolution is known. This is used to obtain upper-bound estimates on the spectral radius of T, i.e., lower-bound estimates for the critical mass. This is done for spheres and slabs under the assumption of monoenergetic neutrons and isotropy of the collision-fission process. A numerical example is given for a bare slab as evidence of the accuracy of the bounds. (T.R.H.)

Elementary Particles and Radiations

14940 (BNL-5293) THE PARTIALLY CONSERVED VECTOR STRANGENESS CHANGING CURRENT. Jeremy Bernstein (Brookhaven National Lab., Upton, N. Y.). Dec. 13, 1960. 4p.

The question of conserving a vector strangeness changing current is discussed with respect to the mass difference between nucleons and hyperons. The state of a zero-mass, zero-momentum K′ particle is considered. (D.L.C.)

14941 (JINR-D-607) PRODUCTION OF Ξ^--HYPERONS BY 7 AND 8 BEV/C NEGATIVE PIONS. Kan[g]-chang Wang, Tzu- tzen Wang, N. M. Vyriasov, Da-tzao Ding, Hi In Kim, E. N. Kladnitskaya, A. A. Kuznetsov, A. Mihul, Dinh Tu Nguyen, A. V. Nikitin, and M. I. Solov'ev (Soloviev) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 14p.

A study was made of the production and decay of Ξ^- hyperons generated in the interactions of mesons (π^-) in bubble chambers at 6.8 ± 0.6 and 8 Bev/c. Eleven Ξ^- hyperons were obtained. A mean value of 61.9 ± 2.2 Mev was observed for the decay energy. The lifetime of the Ξ^- hyperon was calculated by the maximum likelihood method and found to be $(3.5^{+3.4}_{1.2}) \times 10^{-10}$ sec. The production cross sections were found to be $3.6^{+2.5}_{2.1}$ μb per nucleon at 6.8 Bev/c and $10.6^{+4.4}_{3.2}$ μb per nucleon at 8 Bev/c. (auth)

14942 (JINR-D-616) ANALYSIS OF ELASTIC PROTON-PROTON SCATTERING AT 8.5 BEV. I. N. Silin and B. A. Shahbazyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1960. 9p.

An assumption was made for the radial dependence of the scattering potential being taken in the form of the Gauss Law: $V = (u + iw)e^{-\gamma^2 r^2}$. Models were developed for the collision of purely absorbing identical spinless particles, spinless identical particle collisions in the presence of potential scattering, and interactions depending on proton spins. Work is being done on a model to show the strong difference of phases in the singlet and triplet states, which may be realized for purely imaginary potential forms. Calculations were carried out for $l_{even\ max} = 28$ and $l_{odd\ max} = 29$. The results of a model calculation are given for the complex potential of the form: $V = -\{(u_1 + iw_1) + (-1)^{s+1}(u_2 + iw_2)(\vec{\sigma}_1 \cdot \vec{\sigma}_2)\} - e^{-\gamma^2 r^2}$. (B.O.G.)

14943 (JINR-D-647) ON K^0 AND $\overline{K}^0$ MASSES. E. O. Okonov, M. I. Podgoretskii (Podgoretsky), and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Lab. of Theoretical Physics). 1960. 7p.

The upper limit of the difference between the inertial masses of the K^0 and $\overline{K}^0$ is estimated. A possibility is shown of an experimental investigation of the gravitational properties of the $\overline{K}^0$. (auth)

14944 (NYO-2242) ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS AT 152 MEV (thesis). William P. Kovacik (Carnegie Inst. of Tech., Pittsburgh). July 1960. Contract AT(30-1)-882. 60p.

The differential elastic and total cross sections for 152-Mev negative pions on hydrogen were measured. An analysis of the incident pion beam from the synchrocyclotron was made with a Cerenkov counter, which yielded an (11 ± 1)% contamination of negative muons and electrons. In order to detect only elastically scattered pions, coincidences were demanded between the particles in the scattered beam and the recoil protons that are associated with elastically scattered pions. At the angles where the protons were not energetic enough to leave the target a Cerenkov counter was used to separate the pions from electrons. The scattered pion beam was found to be contaminated with up to 20% electrons at some angles. A total cross section of 63.7 ± 2.0 mb was measured. A least squares fit to the differential cross section indicates that only S and P partial waves are involved. Integration of the differential cross section yields a total elastic cross section of 20.1 ± 0.7 mb. The real part of the forward scattering amplitude, $|D^b_-|$, is determined to be $0.190^{+0.021}_{-0.021}\ \hbar/m_\pi c$. Within the errors this value of $|D^b_-|$ agrees with the value calculated from the pion dispersion relations for the coupling constant $f^2 = 0.08$. (auth)

14945 (NYO-9279) PRECISE MEASUREMENTS OF THE MEAN LIVES OF μ^+ AND μ^- MESONS IN CARBON (thesis). Richard A. Reiter (Carnegie Inst. of Tech., Pittsburgh). Aug. 1960. Contract AT(30-1)-882. 64p.

The lifetimes of approx 6 million positive mu mesons were measured, using a crystal controlled oscillator as a

clock. The resulting decay curve was analyzed on a digital computer and gave a mean life of 2.211 ± 0.003 μsec. The mean life of negative mu mesons in carbon was measured and found to be 2.043 ± 0.003 μsec. The resulting nuclear capture rate is $(0.373 \pm 0.011) \times 10^5$/sec, assuming that the decay rate of a negative mu meson bound in carbon is equal to the decay rate of the positive mu meson. (auth)

14946 (NYO-9679) A THEORY OF HYPERFRAGMENTS. II. MESIC DECAY OF HYPERFRAGMENTS. Syurei Iwao (Rochester, N. Y. Univ.). Feb. 28, 1961. Contract AT(30-1)-875. 55p.

Mesic decay of hyperfragments is discussed systematically on the basis of a previous model for hyperfragments. The general formalism for the two-body and three-body mesic decay was developed. The polarization-direction correlation and the angular correlation for the two-body and the three-body decays are discussed together with the decay probability. The formalism was developed so as to include the isotopic spin selection rule ($\Delta I = \frac{1}{2}$ and $\frac{3}{2}$) for the mesic decays. The theory was applied especially for the low mass number hypergragments where it was found that the branching ratios of the two-body and the three-body mesic decays of ${}^3H_\Lambda$ and ${}^4H_\Lambda$, $({}^3H_\Lambda \rightarrow {}^3He + \pi^-)/({}^3H_\Lambda \rightarrow D + p + \pi^-)$ and $({}^4H_\Lambda \rightarrow {}^4He + \pi^-)/({}^4H_\Lambda \rightarrow {}^3H + p + \pi^-)$, could be used for the determination of the spins of both hyperfragments. The fraction of the p-wave decay rate for the free Λ decay obtained from the reaction ${}^5He_\Lambda \rightarrow {}^4He + p + \pi^-$ where the decay proceeds through two-resonant states ($p_{3/2}$ and $p_{1/2}$) is given by $p^2/(s^2 + p^2) \approx 0.4$ which gives the spin zero of ${}^4H_\Lambda$ in connection with the Dalitz and Liu plot and hence odd parity for the kaon. The decay rate of the charged and the neutral modes is always 2/1 if and only if the condition obtained by Okubo, Marshak, and Sudarshan is satisfied. Finally it is shown that the final state interaction for the two-body mesic decay can be described by the pion and residual nucleus scattering phase shifts by making use of invariance of the total S-matrix of the decay processes under the Wigner (weak) time reversal. (auth)

14947 (NYO-9680) HAMILTONIAN DYNAMICS OF RELATIVISTIC PARTICLES. E. C. G. Sudarshan (Rochester, N. Y. Univ.). Mar. 2, 1961. Contract AT(30-1)-875 7p.

The canonical (hamiltonian) formulation of a relativistic dynamical theory is outlined, and the existence and explicit construction of general hamiltonian theories of relativistic interacting particles are discussed. These hamiltonian theories are shown to contain certain elements of arbitrariness which are eliminated in manifestly covariant formulations. (D.L.C.)

14948 (TID-12118) Y* AND K* IN STRONG INTERACTIONS. J. Franklin and S. F. Tuan (Brown Univ., Providence). [Mar. 1, 1961]. Contract AT(30-1)-2262. 10p.

Theoretical discussions are given of an excited hyperon Y* and an excited K* state appearing as pole terms in $\bar{K}N$ and $\bar{\Lambda}N$ dispersion relations, respectively. The importance of a convincing determination of the (Σ, Λ) relative parity is emphasized. Theoretical models are concluded to depend sensitively on the assumption that (Λ,Σ) parity is even, though the Sakurai theory is apparently independent of this assumption. Graphical representations are given of the imaginary part of the $\bar{K}$-p scattering amplitude, ImT and $\mathrm{Im}T_{I=0}$, as functions of momentum for the region of unphysical K^--p energies for solution (a−). The $\bar{K}^*$ contribution in the intermediate state to $\bar{K}N$ low energy scattering is shown. (B.O.G.)

14949 (TID-12143) EFFECTS OF PARITY NONCONSERVING INTERNUCLEON POTENTIALS ON THE PHOTOEFFECT IN H^2 AND H^3. R. J. Blin-Stoyle (Oxford Univ. Clarendon Lab.) and Herman Feshbach (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [1960?]. Contract AT(30-1)-2098. 17p.

Several effects of non-parity conserving potentials on the photodisintegration of deuterons, on radiative neutron capture by hydrogen and deuterium were estimated using a non-parity conserving potential. Observation of the correlation of the circular polarization with the direction of emission of the gamma rays emitted in the radiative neutron capture by deuterium appears to be the most promising. (auth)

14950 (UCRL-9527) EMULSION AND BUBBLE-CHAMBER STATISTICS FOR THE DETERMINATION OF TRACK DENSITY. Akbar Ahmadzadeh (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 12, 1961. Contract W-7405-eng-48. 17p.

The likelihood function is given as a function of the coefficient of the exponent. From this function the exponential coefficient was calculated and the statistical accuracy determined. It is also shown how, with a given amount of experimental data, maximum statistical accuracy is achieved in the determination of the track density. (auth)

14951 (AEC-tr-3972(p.157-204)) STATISTICAL THEORY OF THE MULTIPLE PRODUCTION OF PARTICLES. S. Z. Belen'kii, V. M. Maksimenko, A. I. Nikishov, and I. L. Rozental'. Translated from Uspekhi Fiz. Nauk, 62: No. 2, 1-36(1957).

The statistical theory of multiple processes proposed by Fermi is outlined. The degree of approximation of this approach is evaluated. The allowance in the statistical factor for the laws of conservation of energy, linear momentum, electrical charge, difference between the number of nucleons and antinucleons, strangeness, and isotopic spin is discussed. The effective matrix element for the interaction between particles was evaluated with emphasis on the choice of volume. The isotopic spin, identity, and distribution of particles with respect to charge states were determined. A general formula for the magnitude of the volume in $3(N-1)$ dimensional phase space occupied by a system of N particles was derived. The momentum distribution of secondary particles was calculated. A comparison was made of theoretical and experimental data for $N-N$ and $\pi-N$ interactions at energies of 1 to 5 Bev. Applications of statistical theory to processes associated with annihilation of antinucleons is discussed. The method of finding the charge distributions of reaction products is outlined. The relationship of charge distribution and isotopic spin invariance was determined. (M.C.G.)

14952 (UCRL-Trans-499(L)) THEORY OF DISPERSION RELATIONS. N. N. Bogolyubov, B. V. Medvedev, and M. K. Polivanov. Translated by S. G. Brush from a book published by Moscow State Technical Publishing House, 1958. 200p.

A monograph is given which contains an exposition of the methods of dispersion relations in quantum field theory and the closely related questions of the spectral representation of Green's functions. The basic principles which are necessary for the derivation of dispersion relations are formulated. General relations are established between radiation operators for fields of real particles. A proof is given of the spectral representations of Kallen and Lehmann, which is based on a study of the analytic properties of the vacuum matrix elements of corresponding radiation op-

erators. Proofs of the dispersion relations are included with specifications for actual scattering processes. (B.O.G.)

14953 NEW METHOD IN STATISTICAL THEORY OF PARTICLE PRODUCTION AT 1 TO 100 GEV ENERGY. R. Hagedorn (CERN, Geneva). Fortschr. Physik, 9: 1-28 (1961). (In German)

After a discussion of the Fermi concept and the difficulties involved in its application, a list of not too well-confirmed reasons for the difficulties is given. Then each reason is eliminated citing the works which report the new information. The new basis for the statistical theory derived from the S-matrix is briefly described. Other sections deal with calculation of the phase-space integral by a Monte Carlo method, and evaluation and reduction of the calculated spectra and phase-space integral on physical assertions. A comparison with different experiments is made. (T.R.H.)

14954 INELASTIC INTERACTIONS BETWEEN HIGH ENERGY PARTICLES. V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Physik, 9: 29-41(1961). (In English)

Calculation difficulties of the Fermi theory are pointed out, and how computer techniques and new experimental facilities make it possible to study high energy interactions more fully is discussed. The problems considered are: comparison of experimental data with Fermi theory calculations, a model of central and peripheral collisions, energy spectrum of peripheral mesons in a quick nucleon, resonance interaction of pions, multiple production of strange particles, and interactions of particles at very high energies. (T.R.H.)

14955 SMALL ANGLE ELASTIC SCATTERING OF HIGH ENERGY PARTICLES. V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Physik, 9: 42-9(1961). (In English)

Some problems associated with interpretation of small-angle scattering measurements at high energies are treated. These include: real part of elastic scattering amplitude at high energy, elastic scattering of pions on nucleons, elastic scattering of nucleons and antinucleons on nucleons, and phenomenological analysis of elastic scattering of high energy particles. (T.R.H.)

14956 ELECTROMAGNETIC INTERACTIONS OF ELECTRONS AND POSITRONS AT 620 MEV IN PROPANE. E. Malamud and R. Weill (Cornell Univ., Ithaca, N. Y.). Helv. Phys. Acta, 33: 991-3(1960). (In French)

A 1-Bev γ beam passing through a copper target produces electrons which are then separated according to energy. A 780 ± 10 Mev beam is then introduced into a propane bubble chamber. A reversal of the direction of the magnetic field of the pair spectrograph replaces electrons with positrons of the same energy. The in-flight annihilation of positrons and bremsstrahlung reactions were studied. The cross section for positron annihilation was calculated as $\sigma_{exp} = 1.34 \pm 0.24$ mb/electron; the theoretical value is 1.42. The differential cross section for values of $\underline{\nu}$ ($\underline{\nu} = k/E_0$, where k is the photon energy and E_0 is the energy of the primary positron or electron) from 0.82 to 1.00 was determined and the results tabulated. The total cross sections were determined experimentally and the values obtained agreed well with theoretical values. (J.S.R.)

14957 INTERACTION OF MUONS AT 0.2 TO 1.3 BEV WITH ELECTRONS. A. Heym (Ecole Polytechnique de l'Universite, Lausanne, Switzerland). Helv. Phys. Acta, 33: 995-7(1960). (In French)

The interactions of cosmic muons with atomic electrons in lead screens were studied. The experimental percentages of muons of various energies were determined, using a correction for the zero effect and for the probability of electron detection by Geiger counters. Theoretical determinations of the percentages were made beginning with the cross sections for the production of knock-on electrons, bremsstrahlung, and pairs. The theoretical results obtained agree satisfactorily with the experimental values. (J.S.R.)

14958 ANALYTICAL PROPERTIES OF S MATRIX AND UNIQUENESS OF THE SCATTERING POTENTIAL. A. O. Barut and K. H. Ruei (Syracuse Univ., N. Y.). J. Math Phys., 2: 181-7(Mar.-Apr. 1961).

The Schrödinger equation with the complex momentum k leads to an S matrix with very simple analytical properties. It differs from the conventional S matrix as little as one wishes on the real k axis, but it has, in general, completely different analytical behavior outside the real axis. The present formulation removes some of the unsatisfactory features of the conventional formalism in the sense that no redundant poles can occur and a phase shift determines the scattering potential uniquely. The complex analytical behavior of the S matrix, in particular at infinity, is discussed and the theory is extended to Klein-Gordon and Dirac equations with central potential. (auth)

14959 STRUCTURE OF THE MANY-CHANNEL S MATRIX. Roger G. Newton (Indiana Univ., Bloomington). J. Math. Phys., 2: 188-97(Mar.-Apr. 1961).

The nonrelativistic elastic and inelastic scattering of two particles with internal degrees of freedom, or reactions giving rise to two particles, are considered. It is shown under very general conditions that all elements of the S matrix can be simply obtained from a single analytic function of all channel momenta, the Fredholm determinant of the scattering and reaction integral equations. Its properties are investigated and the restrictions are established which are necessary and sufficient in order to assure that the unitarity condition is fulfilled. The square well and a superposition of Yukawa potentials are considered as examples. (auth)

14960 PRODUCTS OF PRINCIPAL VALUE SINGULARITIES USED IN THE FORMAL THEORY OF SCATTERING. S. Tani (Washington Univ., St. Louis). J. Math Phys., 2: 198-201(Mar.-Apr. 1961).

A mathematically neat derivation is given of the relation between the S matrix and the transformation function for a finite time. It is shown that one can dispense with the adiabatic switching on and off, and yet one reaches the same results as when one employs it. Necessary conditions are discussed for the validity of this statement. Systematic prescriptions are given of handling products of principal value singularities, which is relevant to the scattering theory in momentum space. (auth)

14961 TENSOR AND SPINOR FORMALISM INCLUDING PARITIES. J. Winogradzki (Institut Henri-Poincaré, Paris). J. phys. radium, 21: 835-45(Dec. 1960). (In French)

A formalism is presented based on the systematical use of the eight second rank spinors, the components of which are invariant under the transformations of the full Lorentz group. The great simplification brought out by this formalism, in particular for the calculation of the parities, is shown by the solution of some typical problems about spinor forms. Using the eight second rank spinors with invariant

components as operators, one forms from every first rank spinor Ψ four spinors of the same variance as Ψ and four spinors contragradient to Ψ. As example of application of the new formalism to the study of a spinor field, these eight spinors are examined when Ψ is the Dirac field. The study of the first class shows the analogy between the sign changes of the charge and of the mass and gives the relative parities of any two conjugated fields. The knowledge of the second class allows the construction of new lagrangians. (auth)

14962 THE FUSION OF TWO PARTICLES IN FUNCTIONAL THEORY. Florence Aeschlimann (Institut Henri-Poincaré, Paris). J. phys. radium, 21: 859-62(Dec. 1961). (In French)

A study is made of a system of two particles with spin in relativistic functional theory. Equation of the barycentric wave, equations of the relative motion, and the reduced equation are obtained. In the states of the system, in some cases there exist states where the relative waves are constants. This case corresponds to vanishing relative motion. In the case of two particles of spin $\frac{1}{2}$ of the same mass, a fused system is obtained which is equivalent to a particle with spin 1. From this result, by the approximation giving the usual wave mechanics, the equations given by the fusion method are obtained. The fusion method is thus justified and its physical significance is apparent. (auth)

14963 CALCULATED ENERGY DISSIPATION DISTRIBUTION IN AIR BY FAST ELECTRONS FROM A GUN SOURCE. John E. Crew. J. Research Natl. Bureau Standards, 65A: 113-16(Mar.-Apr. 1961).

Results of calculations on the energy dissipation distribution for electrons from a point collimated (gun) source in an infinite air medium are presented. The calculation was made for a monoenergetic source of 0.4 Mev electrons. The method of moments was employed, fitting the two spatial variables separately. (auth)

14964 RANGE OF PROTONS IN THE AGFA K2 NUCLEAR EMULSION. L. Medveczky and G. Somogyi (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Magyar Tudományos Akad. Atommag Kutató Intezéte (Debrecen). Közlemények, 2: No. 3, 4p.(1960). (In English)

By measuring the range energy of recoil protons produced in the nuclear emulsion by reactions $H^2(d,n)He^3$ and $H^3(d,n)He^4$, calibration points were obtained to determine the range-energy relation of the Agfa K2 emulsion. The measured ranges showed good agreement within errors with results of calculations for Agfa K2 emulsion containing 60% relative humidity. (auth)

14965 MESIC DECAYS OF HYPERNUCLEI FROM K^--CAPTURE. II. BRANCHING RATIOS IN THE CHARGED MESIC DECAY MODES OF $^3H_\Lambda$, $^4H_\Lambda$, $^4He_\Lambda$ AND $^5He_\Lambda(^+)$. R. G. Ammar (Univ. of Chicago), R. Levi Setti, W. E. Slater, S. Limentani, P. E. Schlein, and P. H. Steinberg. Nuovo cimento (10), 19: 20-35(Jan. 1, 1961). (In English)

Branching ratios in the charged mesic decay modes of hyperfragments with charge $Z \leq 2$ and mass number $A \leq 5$ are presented, based on 162 observed events. Such relative frequencies are relevant in discussing the consequences of charge independence, the $\Delta T = \frac{1}{2}$ rule as applied to hypernuclei, and the spin dependence of the Λ-nucleon interaction. In particular, the ratio R_4 of (π^--recoil) with respect to all π^- decays for H^4_Λ is found to be $R_4 = 0.67^{+0.06}_{-0.05}$, where the errors represent statistical uncertainties only. Comparing this with the curves of R_4 vs. (p/s) calculated by Dalitz and Liu on the two assumptions (J = 0, 1) regarding the spin of H^4_Λ, it is concluded that the value J = 0 is more probable. If this spin assignment is accepted, it may be inferred that for the ratio of p- to s-wave amplitude in the charged decay of the free Λ, $0.45 \leq p/s \leq 1.4$. Finally, although they should have the same general configuration as the π^- events, no examples of decays involving either the emission of a π^+ or a charged lepton are identified in the present sample. (auth)

14966 EFFECT OF FINAL STATE INTERACTIONS ON THE (Σ^-,d) CAPTURE REACTIONS. Yung Yi Chen (Univ. of Maryland, College Park). Nuovo cimento (10), 19: 36-45(Jan. 1, 1961). (In English)

The effects of the two-neutron final state interaction in the reaction $\Sigma^- + d \rightarrow (\Lambda^0 \text{ or } \Sigma^0) + n + n$ are calculated using the impulse approximation with the assumption of S-wave absorption and even relative parity between hyperons. Comparing the results with those neglecting all final state interactions, it is found that the Σ^0 production can be enhanced by a factor ~6 while the Λ^0 production is increased by only ~1. The experimental results on the branching ratio of the two hyperon productions can be fit with a less extreme assumption about the spin dependence of the transition matrix for the reaction $\Sigma^- + p \rightarrow \Sigma^0 + n$, although an appreciable amount of spin dependence is still required. The effect of the dineutron final state interaction on the Λ^0 momentum spectrum is calculated as a function of the spin dependence of the Λ^0 production process. The experimental data, however, are not sufficient to determine this spin dependence. (auth)

14967 THE POLARIZATION OF THE PROTON FROM THE PROCESS $\gamma + p \rightarrow p + \pi^0$ IN THE REGION OF THE HIGHER RESONANCES. R. Querzoli, G. Salvini, and A. Silverman (C.N.R.N., Frascati, Italy). Nuovo cimento (10), 19: 53-76(Jan. 1, 1961). (In English)

The polarization of the recoil proton in the photoproduction process $\gamma + p \rightarrow p + \pi^0$ is measured with the beam of the Frascati electrosynchrotron at an angle of 90° in the c.m. system, in the energy interval 500 to 900 Mev. A counter technique is used, and the polarization of the proton is revealed by the left to right asymmetry in the elastic scattering of the protons in a carbon target. The experimental results are given. A definite polarization is found, always of the same sign and equal to $-0.4 \pm .14$, $-0.63 \pm .23$, $-0.6 \pm .25$, $-0.57 \pm .12$, $-0.38 \pm .09$, $-0.5 \pm .17$, $-0.5 \pm .22$ at the γ-ray energies of 560, 610, 650, 700, 750, 800, and 850 Mev respectively. A discussion is given of these experimental results, together with the data of angular distributions; it is concluded that the results are in agreement with the hypothesis that the second resonance is a transition ($E1,d^{3/2}$) and the third one is a transition ($E2,f^{5/2}$). (auth)

14968 THE EFFECT OF A PION-PION INTERACTION ON LOW-ENERGY MESON-NUCLEON SCATTERING. PART II. J. Bowcock, N. Cottingham, and D. Lurié (C.E.R.N., Geneva). Nuovo cimento (10), 19: 142-53(Jan. 1, 1961). (In English)

An investigation is made of the consequences of a pion-pion interaction on low energy pion-nucleon phase shifts. Confining of considerations to the isotopic spin flip combination of waves made possible isolation of effects due to a pion-pion interaction in the T = 1 state. Such an interaction is found to be definitely necessary to give agreement with experiment, and a simple resonance in the J = 1, T = 1 state gives a good fit to the data. (auth)

14969 PARITY CONSERVATION AND BARYON MASS-DIFFERENCES IN STRONG INTERACTIONS. N. Dallaporta and L. K. Pandit (Università, Padua). Nuovo cimento (10), 19: 171-8(Jan. 1, 1961). (In English)

A scheme of strong interactions is proposed which takes account of the baryon mass-differences. It is found that P conservation follows automatically for the whole Lagrangian of this scheme once CP invariance is assumed. It is shown that this is due to the fact that the Lagrangian can be considered as consisting of different pieces, each of which satisfies certain symmetry conditions. (auth)

14970 NATURE OF THE $K^+ + n \rightarrow K^0 + p$ ANGULAR DISTRIBUTION. E. Helmy, D. J. Prowse, and D. H. Stork (Univ. of California, Los Angeles). Nuovo cimento (10), 19: 179-82(Jan. 1, 1961). (In English)

The charge-exchange (C.E.) reaction $K^+ + n \rightarrow K^0 + p$ is studied. K^+ mesons at 260 Mev strike emulsion nucleons; the emergent protons are analyzed and separated into C.E. protons and non-C.E. protons (from $K^+ + p$ interactions). The forward and backward peaking of the C.E. reactions is found to be in agreement with the peaking predicted by an attractive p-wave interaction in the p-state for T = 0. (T.F.H.)

14971 SOME TESTS FOR COMPOUND MODELS OF ELEMENTARY PARTICLES. G. Bhamathi (Univ. of Madras), S. Indumathi, A. P. Balachandran, and N. G. Deshpande. Nuovo cimento (10), 19: 192-4(Jan. 1, 1961). (In English)

Experimental means are suggested for testing the validity of some compound models of elementary particles. Asymmetry parameters of decay products of hyperons are predictable from decay characteristics of the constituent particles. The effective range theory offers a second approach, in that there is a relation between the binding energy of a compound particle and the scattering lengths, effective ranges, and S-wave phase shifts of the constituent particles. A third method involves requiring that charge conjugation and parity be valid operators, in which case it is possible to derive selection rules for $K^+ \bar{K}^0$, $K^- K^0$, $K^+ K^-$, or $K^0 \bar{K}^0$ annihilation into pions. These selection rules may be used in testing some compound models. Examples of hyperon compound models, such as Σ, Ξ, and Λ are given, and it is remarked that similar arguments may be used for baryons. (T.F.H.)

14972 ON PION PRODUCTION IN COULOMB FIELD. B. Ferretti (Università, Bologna). Nuovo cimento (10), 19: 193-4(Jan. 1, 1961). (In English)

The production of pions by a pion in a Coulomb field is discussed. It is shown that one-pion production may be observed at lower energies than two-pion production. One-pion production, however, is in a disadvantageous position for study in that symmetry laws require a "fourfold vertex" of three pions and one electromagnetic line. Two-pion production is studied using a resonant state π-π interaction. Angular momentum values of 0 and 1 and masses up to four pion masses are considered for the resonant state, and two-pion production cross section ranges are given. An example is presented of a lead target and 20 Bev incident pions. Information as to the nature of the π-π resonance may be obtained from two-pion production data. The presence of effects proportional to Z^2 and A^2Z^2 is discussed. (T.F.H.)

14973 MEASUREMENT OF THE TOTAL CROSS SECTION FOR π^+-p AND π^--p AT 400 Mev TO 1.5 Gev. J. C. Brisson, J. F. Detoeuf, P. Falk-Vairant, L. Van Rossum, and G. Valladas (Centre d'Études Nucléaires, Saclay, France). Nuovo cimento (10), 19: 210-33(Jan. 16, 1961). (In Italian)

The total cross sections were measured for π^+-p and π^--p interactions by attenuation in liquid hydrogen of a beam whose energy is known to ±1% and with a total $\Delta P/P$ of ±1.8%. The energies and values for the cross sections at the maxima are: π^-: $T\pi = (605 \pm 6)$ Mev, $\sigma_{tot} = (45.8 \pm 1.8)$ mb, $T\pi_{lab} = (890 \pm 9)$ Mev, $\sigma_{tot} = (58.0 \pm 1.8)$ mb, π^+: $T\pi_{lab} = (1330 \pm 30)$ Mev, $\sigma_{tot} = (38.0 \pm 2.0)$ mb. Results are compiled concerning the elastic and inelastic cross sections obtained by other experimental techniques in the neighborhood of the second and third resonances of π^-. The second and third resonances are discussed. (auth)

14974 NUCLEAR POTENTIAL FOR THE K^+-MESON. T. G. Lim and S. J. Bosgra (Universiteit, Amsterdam). Nuovo cimento (10), 19: 239-44(Jan. 16, 1961). (In English)

The data of K^+-mesons elastically scattered by complex nuclei in G-5 nuclear emulsion are analyzed. Only small angles in the energy region of 40 to 80 Mev are considered. The phase shift to optical model analysis is applied, using the W.K.B.J. approximation for the evaluation of phase shifts. The calculations are based on the assumption that the elastic nuclear scattering potential may be approximated by a real square model. The magnitide is estimated to be (21 ± 5) Mev, if in the relation of the nuclear radius $R = r_0 A^{1/3}$, $r_0 = 1.2 \cdot 10^{-13}$ cm, and to be (17 ± 5) Mev, if $r_0 = 1.4 \cdot 10^{-13}$ cm. (auth)

14975 SCATTERING OF μ-MESONS. R. L. Sen Gupta, S. Ghosh, A. Acharya, M. M. Biswas, and K. K. Roy (Presidence Coll., Calcutta). Nuovo cimento (10), 19: 245-9 (Jan. 16, 1961). (In English)

The scattering of μ-mesons is investigated by means of a rectangular cloud chamber with copper and lead plates placed alternately inside the chamber. μ-mesons after traversing thick layers of iron and lead absorber placed above and below the chamber are made to stop in 7.6 cm of iron layer by an anticoincidence method. The momenta of the scattered μ-mesons are thus well-defined in the region of (1.18 ± 0.05) Bev/c. The observed angular distribution coincides with the point-charge model of the nucleus in the case of lead, and in the case of copper the distribution is just above the predicted curve. (auth)

14976 ELECTROMAGNETIC SCATTERING OF HYPERONS. M. J. Englefield and B. Margolis (Ohio State Univ., Columbus). Nuovo cimento (10), 19: 274-6(Jan. 16, 1961). (In English)

The interaction between the magnetic moment of a neutral hyperon and the charge of a nucleus causes large polarizations in small angle scattering. The feasibility of using this effect to measure the magnetic moment is considered. (auth)

14977 DISPERSION RELATION AND ANALITICITY OF A PRODUCTION AMPLITUDE. G. Mohan (National Physical Lab., New Delhi, India). Nuovo cimento (10), 19: 331-43 (Jan. 16, 1961). (In English)

A dispersion relation and certain analyticity properties of the amplitude for an inelastic scattering process like $n + \pi \rightarrow n' + \pi' + \pi''$ were studied on the basis of the Jost-Lehmann-Dyson integral representation of the causal commutator. (auth)

14978 ANALYTIC PROPERTIES OF DEUTERON PHOTODISINTEGRATION MATRIX ELEMENT FOR FIXED ENERGY. A. Martin (European Council for Nuclear Research, Geneva). Nuovo cimento (10), 19: 344-55(Jan. 16, 1961). (In English)

A study is made of the analytic properties of non-relativistic matrix elements for deuteron photodisintegration, at fixed energy and variable angle. The neutron and proton are assumed to interact through a static potential which is a superposition of Yukawa potentials. Complications due to spin are negligible. The results coincide with the predictions of a Mandelstan-type representation.

In the beginning the first terms of the matrix elements are calculated by the field theory in which the deuteron is treated as an elementary particle coupled with a neutron and a proton. The interest lies in the fact that one of the incoming particles is a bound state, and that anomalous thresholds are present. An analogous result, concerning the analyticity of the corresponding partial wave amplitudes as a function of energy, is discussed. (tr-auth)

14979 DISPERSION THEORETIC APPROACH IN NUCLEON-NUCLEON SCATTERING. S. Furuichi and S. Machida (Rikkyo Univ., Tokyo). Nuovo cimento (10), 19: 396-9(Jan. 16, 1961). (In English)

A theoretical dispersion treatment for nucleon-nucleon scattering is presented. The method presented is based on the potential model, rather than on the scattering matrix. Using the impact parameter b_e, it is shown to be possible to isolate phenomena which are insensitive to the detailed inner structure of the potential. Effects which are dependent on the potential form, such as n-pion exchange (n = 1,2,...) are also shown to be calculable. (T.F.H.)

14980 ABSORPTIONS IN FLIGHT OF Σ^- HYPERONS IN EMULSION NUCLEI. B. D. Jones, B. Sanjeevaiah, and J. Zakrzewski (Univ. of Bristol, Eng.). and D. H. Davis. Nuovo cimento (10), 19: 400-3(Jan. 16, 1961). (In English)

Two events are recorded in which Σ^- hyperons are captured in flight by emulsion nuclei. It is found that in one of the captures, the Σ^- hyperon undergoes a reaction of the type $\Sigma^- + O^{16} \rightarrow {}^{4,5}_{\Lambda^0}He + \alpha + \alpha + H^{1,2,3}$ + neutrons. No hyperfragment results from the second Σ^- hyperon capture; it is assumed that the Λ^0 hyperon is trapped inside the target nucleus. (T.F.H.)

14981 DIFFERENCE IN THE MULTIPLE SCATTERING OF ELECTRONS AND POSITRONS. B. P. Nigam (Univ. of Rochester, N. Y. and General Dynamics/Electronics, Rochester, N. Y.) and V. S. Mathur. Phys. Rev., 121: 1577-80 (Mar. 15, 1961). (NYO-9368)

The difference in the multiple scattering of electrons and positrons was calculated on the basis of the work of Nigam, Sundaresan, and Wu. The results are compared with the experimental work of Henderson and Scott and are found to be in good agreement. (auth)

14982 BOUNDS ON SCATTERING PHASE SHIFTS FOR COMPOUND SYSTEMS. Leonard Rosenberg and Larry Spruch (New York Univ., New York). Phys. Rev., 121: 1720-26(Mar. 15, 1961).

An extension of recently developed methods determines a rigorous upper bound on $(-k \cot\eta)^{-1}$, where η is the phase shift, for the general one-channel scattering process. The method, unfortunately, required tuncation of the various potentials, but it should generally be possible, in practice, to so truncate the potentials that the difference between the phase shifts of the original problem and of the problem for which a bound is obtained is insignificant. In the course of the development it is necessary to introduce, for compound system scattering, an absolute definition of the phase shift, not simply a definition modulo π. The definition chosen is to take the projection of the full scattering wave function on the ground-state wave function of the scattering system, and to treat the resultant one coordinate function as if it were the scattering wave function for a particle on a center of force. Though irrelevant with regard to the determination of a bound on $\cot\eta$, it is interesting that at least for some simple cases this definition automatically increases the phase shift by at least π whenever the Pauli principle introduces a spatial node into the scattering wave function. The triplet scattering of electrons by hydrogen atoms provides an example. (auth)

14983 ANALYSIS OF GAMMA-GAMMA POLARIZATION-DIRECTIONAL CORRELATIONS INVOLVING MULTIPOLE MIXTURES. M. B. Martin, R. G. Arns, and M. L. Wiedenbeck (Univ. of Michigan, Ann Arbor). Phys. Rev., 121: 1732-4(Mar. 15, 1961).

A method is described for the graphical analysis of the gamma-gamma polarization-directional correlation when one or both gamma rays involve a mixture of dipole and quadrupole radiation. The case in which the polarization of the mixed gamma ray is observed is treated in detail. (auth)

14984 REACTION $\bar{p} + p \rightarrow \bar{Y} + Y$. Janice Button, Philippe Eberhard, George R. Kalbfleisch, Joseph E. Lannutti, Gerald R. Lynch, Bogdan C. Maglić, M. Lynn Stevenson, and Nguyen H. Xoung (Univ. of California, Berkeley). Phys. Rev., 121: 1788-97(Mar. 15, 1961). (UCRL-9347)

The study of the interaction $\bar{p} + p \rightarrow \bar{\Lambda} + \Lambda$, performed with the 72-inch hydrogen bubble chamber, yielded 11 events in a total of 21 100 antiproton interactions at 1.61 Bev/c. The cross section for $\bar{\Lambda} + \Lambda$ production was estimated as 57 ± 18 μb. Eight of the 11 antilambda particles went forward in the c.m. system. At the higher momentum of 1.99 Bev/c, one single-V and one double-V event fitting $\bar{\Lambda} + \Lambda$ production unambiguously and one single-V and one double-V event fitting $\bar{\Sigma}^0 + \Lambda$ or $\Sigma^0 + \bar{\Lambda}$ were observed in 4920 antiproton interactions. These events yield a $\bar{\Lambda}-\Lambda$ production cross section of 55 ± 40 μb; this value is consistent with that predicted by the ratio of phase space on the basis of the 1.61-Bev/c data. No charged antisigma events were observed at the higher momentum. Three stages of particle separation utilizing velocity-selecting spectrometers were employed. At the lower momentum, background pions were one-third as numerous as antiprotons at the bubble chamber and the flux of antiprotons was about one per picture. At the higher momentum, the background pion to antiproton ratio was 1.8, and the flux of antiprotons was one every 6 pulses. Delta rays on incident interacting tracks were used to determine beam composition. (auth)

14985 PHOTOPRODUCTION AND DETECTION OF THE TWO-MESON BOUND STATE. Jack L. Uretsky and T. R. Palfrey, Jr. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 121: 1798-1803(Mar. 15, 1961).

The detection of a photoproduced two-pion bound system was investigated. The general detection problem is discussed briefly; the branching ratio between $2\pi^0$ and $2\gamma^0$ decay modes is calculated; and the total photoproduction cross section is estimated in terms of the binding energy of the two-pion state both by field-theoretic and by phase-space arguments. It is concluded that if the binding energy is of the order of 10 Mev the state should be detectable in photoproduction experiments, and the binding energy should be measurable. (auth)

14986 CLOUD-CHAMBER STUDY OF HARD COLLISIONS OF COSMIC-RAY MUONS WITH ELECTRONS. R. F. Deery and S. H. Neddermeyer (Univ. of Washington, Seattle). Phys. Rev., 121: 1803-14(Mar. 15, 1961).

The energy distribution of the secondary electrons produced in targets of carbon or paraffin by the μ-e scattering process for muon momenta in the range 5 to 50 Bev was measured for electron energies up to 10 Bev, or c.m. momentum transfer up to 100 Mev. A vertical array of three cloud chambers immersed in a magnetic field of 11,000 gauss was used with a fourfold coincidence system. Two flat rectangular proportional counters, suitably biased, together with two Geiger-Müller trays, provided fair rejection of uneventful penetrating particles and a high ef-

ficiency for selection of the narrow electronic showers characteristic of the high-energy electromagnetic events. On 5900 counter triggered photographs there were 291 accepted events, having one or more (±) electrons with energy ≥0.10 Bev, believed to originate in μ-e collisions in the (carbon or paraffin) target above the top chamber, from incident muons in the momentum interval 5 to 50 Bev. The data are compared with a calculation based on the Bhabha formula for spin ½ muons, taking into account the momentum distribution of the incident muons, the energy loss and shower development in the target and the chamber walls, and a theoretical efficiency factor. Arguments are given to show that direct pair production and bremsstrahlung of the muons in the target and in the Pb shield above the apparatus produce negligible effects. The experiment permits a reliable measurement of only the relative distribution. When arbitrarily normalized, the calculated distribution is in fairly good agreement with the data, except for a small systematic difference suggesting an excess of observed events for the harder collisions. Although the discrepancy is interpretable as a statistical fluctuation, the data are fitted much better over the entire range when the basic cross section is modified by a "form factor," F^2 (greater than unity), with $F = 1 + |q^2| \lambda_\mu^2$ where q is the invariant of the 4-momentum transfer in units of $\hbar$, and λ_μ is the Compton wavelength of the muon. This may be the first indication of a deviation from standard quantum electrodynamics for hard μ-e collisions. More strongly it shows that, if there is a deviation, it is not representable by a form factor less than unity. (auth)

14987 CONTINUATION OF SCATTERING AMPLITUDES AND FORM FACTORS THROUGH TWO-PARTICLE BRANCH LINES. Reinhard Oehme (Univ. of Chicago). Phys. Rev., 121: 1840-8(Mar. 15, 1961).

It is shown that scattering amplitudes and form factors have two-particle branch lines which connect two Riemann sheets. For partial wave amplitudes and form factors the dispersive parts and, except for square root factors, the absorptive parts are regular functions in the cut energy plane except for isolated poles, physical inelastic cuts, and left-hand branch lines. In order to show this it is assumed that, for particles without composite structure, the amplitudes have only such singularities in the physical sheet which correspond to absorptive processes. The analytic properties of absorptive parts are used for a general discussion of structure singularities (anomalous thresholds). These structure cuts are extensions of left-hand branch lines in the second Riemann sheet. An example is given of a dispersion relation on the Riemann surface in which the integral over the two-particle branch line is eliminated. (auth)

14988 RELATIVISTIC PARTICLE DYNAMICS. B. Bakamjian (Pennsylvania State Univ., University Park). Phys. Rev., 121: 1849-51(Mar. 15, 1961).

An instant form of relativistic particle dynamics can be constructed which displays the symmetry properties inherently present in the point form. In this new instant form, interaction terms are introduced in the energy momentum four-vector of the system; physically this is more justifiable than the more customary method of having interaction terms appear in the energy and the three generators of the Lorentz group which give the three infinitesimal displacements in velocity. (auth)

14989 LEPTONIC DECAY OF A Σ^- HYPERON. Paolo Franzini and Jack Steinberger (Columbia Univ., New York). Phys. Rev. Letters, 6: No. 6, 281-3(Mar. 15, 1961).

An example of the leptonic decay of a hyperon $\Sigma^- \rightarrow e^- + \nu + n$ is reported. The interaction is obtained by exposing a 30 in. propane chamber to a 2 Bev π^- beam. It is hypothesized that the Σ is produced by the reaction $\pi^- + p \rightarrow \Sigma^- + K^0 + \pi^+$, and that the Σ^- decays by β^- emission. Alternative decay processes, in which the Σ^- decays by interacting with a proton, are rejected because of energy or probability considerations. (T.F.H.)

14990 PROPERTIES OF THE Y* AS OBSERVED IN THE INTERACTION $K_2^0 + p \rightarrow \Lambda^0 + \pi^+ + \pi^0$. H. J. Martin (Brookhaven National Lab., Upton, N. Y.), L. B. Leipuner, W. Chinowsky, F. T. Shively, and R. K. Adair. Phys. Rev. Letters, 6: No. 6, 283-5(Mar. 15, 1961).

The reaction $K_2^0 + p \rightarrow \Lambda^0 + \pi^0 + \pi^+$ is analyzed in order to detect a Y* resonant state which decays such that $Y^{0}* \rightarrow \Lambda^0 + \pi^0$ and $Y^{+}* \rightarrow \Lambda^0 + \pi^+$. K_2^0 mesons are produced by such reactions as $\pi^- + (p \text{ or } n) \rightarrow (\Lambda^0 \text{ or } \Sigma) + K_2^0 + (0,1, \text{or } 2)\ \pi$. The momentum and angular distributions for 60 events are given, and it is shown that if a Y* state is assumed, its natural width is $0 \leq \Gamma \leq 30$ Mev. The Y* parity, spin, and angular momentum are discussed, and it is noted that the Y* decay is more probably S-wave than P-wave. (T.F.H.)

14991 ELECTROMAGNETIC PROPERTIES OF THE PROTON AND NEUTRON. D. N. Olson, H. F. Schopper, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 6: No. 6, 286-90(Mar. 15, 1961).

The electric and magnetic form factors of the proton and nucleon respectively are found. Deuterons and protons are bombarded by electrons at 0.2 to 1.2 Bev, and momentum transfer and differential scattering cross section data are analyzed. A nucleon model is used in which a charge core containing $+\frac{1}{2}e$ is surrounded by a mesonic cloud having $+\frac{1}{2}e$ for protons and $-\frac{1}{2}e$ for neutrons. Parameters in this model are selected to give close fits to the scattering data. Modifications of the model are discussed. (T.F.H.)

14992 DIRAC AND PAULI FORM FACTORS OF THE NEUTRON. R. Hofstadter (Stanford Univ., Calif.), C. de Vries and Robert Herman. Phys. Rev. Letters, 6: No. 6, 290-3(Mar. 15, 1961).

The electric and magnetic form factors of the neutron are calculated. Deuterons are bombarded with electrons at 0.3 to 0.9 Bev, and measurements of the inelastic scattering cross sections are taken at two sets of energy and scattering angle values which give the same value of q^2 = (momentum transfer)^2. The method of intersecting ellipses is then used to find form factors for the neutron for q^2 = 0, 5, 10, 15, and 20 f^{-2}. Electron scattering by protons from 0.3 to 0.9 Bev is also measured as a means of checking the deuteron scattering. (T.F.H.)

14993 ELECTRIC AND MAGNETIC STRUCTURE OF THE PROTON AND NEUTRON. Robert Hofstadter (Stanford Univ., Calif.) and Robert Herman. Phys. Rev. Letters, 6: No. 6, 293-6(Mar. 15, 1961).

The electric and magnetic form factors of the proton and neutron are derived theoretically as functions of the momentum transfer invariant (q^2). It is proposed that the proton and nucleon are two aspects of the nucleon, which differ only in isotopic spin. The neutron and proton form factors are accordingly divided into scalar and vector parts, and the effects of core charges and Yukawa clouds are discussed. It is noted that the neutron electric form factor is positive, thus requiring a positive outer fringe of charge for the neutron. (T.F.H.)

14994 PION PRODUCTION BY NEGATIVE PIONS. Barry C. Barish, Richard J. Kurz, Paul G. McManigal, Victor Perez-Mendez, and Julius Solomon (Univ. of

California, Berkeley). Phys. Rev. Letters, 6: No. 6, 297-300(Mar. 15, 1961).

The reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ is studied for incident $T_{\pi^-} = 365$ and 432 Mev. The energy spectra of the emergent π^+ mesons are measured at various angles with respect to the incident π^- beam. The differential cross sections are analyzed in terms of pion-pion interactions and pion-nucleon resonances. (T.F.H.)

14995 RESONANCE IN THE K-π SYSTEM. Margaret Alston, Luis W. Alvarez, Philippe Eberhard, Myron L. Good, William Graziano, Harold K. Ticho, and Stanley G. Wojcicki (Univ. of California, Berkeley). Phys. Rev. Letters, 6: No. 6, 300-2(Mar. 15, 1961). (UCRL-9547)

The interaction $K^- + p \rightarrow \overline{K}^0 + \pi^- + p$ is studied at 1.15 Bev/c. It is postulated that the interaction is a 2-step process in which $K^- + p \rightarrow K^{*-} + p$, followed by the decay $K^{*-} \rightarrow \overline{K}^0 + \pi^-$ with a lifetime of 4×10^{-23} sec. The branching of the kinetic energy of the produced protons near $T_p \cong 20$ Mev for most of the 48 interactions studied is explained. The properties of the K^{*-} are investigated, and the existence of such particles as $\overline{K}^*$ and K^* is discussed. (T.F.H.)

14996 CHARGED HYPERON PRODUCTION BY 16-Gev/c π^- MESONS. J. Bartke (European Organization for Nuclear Research, Geneva), R. Bock, R. Budde, W. A. Cooper, and H. Filthuth, et al. Phys. Rev. Letters, 6: No. 6, 303-5(Mar. 15, 1961).

An experiment is described in which π^- mesons at 16 Bev/c impinge on a 30 cm hydrogen bubble chamber. The production of 48 strange particles is observed, including $28\Sigma^+$ and $18\Sigma^-$ hyperons and $2K^+$ mesons. The angular and momentum distributions of the Σ^+ and Σ^- hyperons are calculated from observations of the decays $(\Sigma^+ \rightarrow \pi^+ + n)$ and $(\Sigma^+ \rightarrow p + \pi^0)$. (T.F.H.)

14997 EXISTENCE OF THE ω^0 PARTICLE. R. G. Sachs and B. Sakita (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 6: No. 6, 306-7(Mar. 15, 1961).

The decay $K^+ \rightarrow \omega^0 + \pi^+$ is studied in an attempt to disprove the existence of the ω^0; the ω^0 is assumed to be a 2π or bound 3π resonant state of mass 305 Mev, width <16 Mev, and $J = 0$ or 1. It is shown that the existence of an ω^0 with $J = 0$ leads to the conclusion that the K^+ and K_1^0 lifetimes are nearly equal; this conclusion is in error by a factor of $\sim 10^3$. It is shown that an ω^0 with $J = 1$ should have a production rate competitive with the reaction $K^+ \rightarrow \pi^0 + e^+ + \nu$, but this competition is not observed experimentally. Several possibilities are suggested for the existence of the ω^0, such as $J \neq 0$ or 1, etc. (T.F.H.)

14998 ANALYSIS OF THE ANOMALY IN DOUBLE MESON PRODUCTION IN p + d COLLISIONS AND THE S-WAVE PION-PION INTERACTION. Tran Nguyen Truong (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 6: No. 6, 308-9(Mar. 15, 1961).

The anomalous π-π production in the reactions $p + d \rightarrow He^3 + \pi^+ + \pi^-$, $p + d \rightarrow He^3 + \pi^0 + \pi^0$, and $p + d \rightarrow H^3 + \pi^+ + \pi^0$ is explained by a nonresonant π-π final-state interaction in the $T = 0$ isospin state. An S-wave π-π interaction analysis is carried out, it is found that for an exponential potential well of range $\underline{d}$, attractive scattering lengths $\underline{a}_0$ may be assigned for $T = 0$. For $\underline{d} \leq \underline{a}_0 \leq 3\underline{d}$, reasonable fits to the experimental data are obtained. The inclusion of the $T = 2$ interaction is discussed. (T.F.H.)

14999 TWO PARAMETER APPROXIMATION TO S-WAVE SCATTERING. Daniel M. Greenberger and B. Margolis (Ohio State Univ., Columbus). Phys. Rev. Letters, 6: No. 6, 310-11(Mar. 15, 1961).

A simple two-parameter approximation to Mandelstam scattering amplitudes is presented for a singlet s-wave nucleon-nucleon (N-N) scattering interaction. It is noted that the $\nu = q^2$ plane has 2 branch lines for s-wave N-N scattering, at $\nu \geq 0$ and $\nu \leq -\frac{1}{4}$; ν and q are defined as in the Mandelstam notation. A conformal mapping is introduced which "localizes" the extended singularity for $\nu \leq -\frac{1}{4}$, and which approximates the singularity by a pole. The shape parameter calculated by this method is discussed, and advantages of the method, including conservation of the branch line for $\nu \leq -\frac{1}{4}$, are reported. (T.F.H.)

15000 DISPERSION RELATIONS FOR PRODUCTION AMPLITUDES. Y. S. Kim (Princeton Univ., N. J.). Phys. Rev. Letters, 6: No. 6, 313-15(Mar. 15, 1961).

The Logunov dispersion relation for production amplitudes is discussed. It is shown that this relation is invalid, i.e., that the production amplitude has complex singularities when regarded as a function of the Logunov variables. The reaction $\pi + N \rightarrow \pi + \pi + N$ is analyzed by perturbation theory, and it is found that 4 of the 5 independent variables of the reaction are ignored in the Logunov calculations. The singularities in the Logunov production amplitudes are demonstrated in Feynman diagrams. (T.F.H.)

15001 RECOIL EFFECT IN NON-RELATIVISTIC QUANTUM THEORY OF FIELD. A. V. Tulub. Vestnik Leningrad. Univ., 15: No. 22, Ser. Fiz. i Khim., No. 7, 104-18(1960). (In Russian)

A calculation method convenient for the treatment of the system of a quantized field and a non relativistically moving particle interacting with each other strongly enough is developed. With the help of the two canonical transformations used in the paper of Lee, Low, and Pines the effective hamiltonian with the interaction terms included is constructed. The hamiltonian can be diagonalized by the Wentzel method known in the meson pair field theory. A polaron problem is given as an example. (auth)

15002 AN APPROXIMATE THEORY IN REGARD TO THE QUANTITY OF MOTION RELATIVE TO DEUTERON FISSION REACTION. Teh-Yu Wong (Te-yu Wang), She-Chun Chiu (Hsi-chun Ch'iu), Pei-Wen Lee (Pe-wen Li), and Ming Yu (Min Yu) (Academy of Sciences, China). Wu Li Hsueh Pao, 16: 123-31(1960).

This perturbation equation satisfies the interactions of both the deuteron and target nucleus. The value, $h^2/4m(K'p - Kn)^2$, represents the quantity of motion for the interaction of the deuteron. It is found that kinetic energy for the deuteron interaction and its binding ability can be neglected. This implies generally, that the proton and neutron elements of the deuteron are separate and independent. The equations employed for numerical calculations are given in full detail. (TCO).

15003 THE ELECTRO-MAGNETIC STRUCTURE OF PARTICLES WITH SPIN OF ONE. Hsueh-tan Shih, Liao-fu Lo, and Nien-ning Huang (Inner Mongolian Univ.). Wu Li Hsueh Pao, 16: 331-7(1960).

Scattering experiments with high energy electrons and nucleons are important methods for determining electromagnetic (E-M) nucleon and nuclear structures. Shape factors must be determined, theoretically if not empirically, concerning the E-M structures for particles or nuclei with definite spin. This study is based on the Lorentz group viewpoint. Basic transformation characteristics, along with the Proca equation, are used in a method similar to the Dirac equation for calculating the E-M structure of particles with spin of $\frac{1}{2}$. This method of determination is variational; it may therefore be used in any Lorentz system.

Shape factors thus defined include electric charge distribution, magnetic moment distribution, and electric quadrupole moment distribution. Calculations are also made for elastic scattering of electrons, deuterons, and other nuclei with spin of 1 to determine E-M structure factors of particles with integral spin. (TCO)

15004 π-MESON-ELECTRON SCATTERING AND STRUCTURE OF π MESONS. H. Salecker (Universität, Freiburg i.B.). Z. Naturforsch, 15a: 1023-30(Dec. 1960). (In German)

Meson (π)–electron scattering is proposed as a possibility for investigating the electromagnetic structure of the pion. This experiment requires very high energy, but not necessarily such a high accuracy as the extrapolation procedure of Chew and Low. After a short discussion of the general properties of the electromagnetic form factor of the π meson, the $\pi-e$ and the $e-\pi$ scattering cross sections are calculated. With an energy of 25 Bev and a 10% experimental error one can probe the root mean square radius of the pion down to 0.8×10^{-13} cm, with 50 Bev down to 0.6×10^{-13} cm, and with 100 Bev to 0.36×10^{-13} cm. The rms radius of the pion may be larger than previously assumed, because there exists the possibility of a fairly large $\pi-\pi$ interaction. A complementary possibility for investigating the electromagnetic structure of the pion consists in electro-positron pair annihilation with the creation of a $\pi^{\pm}$ pair. This process will probe the form factor of the π meson for timelike arguments. (auth)

15005 SIMPLE AND MULTIPLE SCATTERING OF CHARGED PARTICLES. E. Keil, E. Zeitler, and W. Zinn (Universität, Wurzburg, Ger.). Z. Naturforsch, 15a: 1031-8 (Dec. 1960). (In German)

The Moliere formulation, going back to the Wentzel method, was evaluated for the range of simple and multiple scattering (mean impact number from 0 to 20). For very small impact numbers the angular distribution could be calculated directly by the Wentzel statistical method, since the contribution of the double-scattered particles could be calculated and the contribution of the triple- and multiple-scattered particles can be neglected. For impact numbers between 0 and 20 an approximation especially suitable for evaluation on a computer was used for integral impact numbers. The results are tabulated in three tables from which the angular distribution, the integrated angular distribution, and the angular distribution determined over the layer thickness can be determined. (tr-auth)

15006 THE SMALL ANGLE THEORY OF MULTIPLE SCATTERING. Hans Fleischmann (Technische Hochschule, Munich). Z. Naturforsch, 15a: 1090-6(Dec. 1960). (In German)

An investigation of the approximation made by Moliere in the derivation of single scattering cross sections is reported, from which only a relativistic correction of the multiple scattering results. A formula was derived. The discrepancy with the results of Hanson et al. on beryllium was traced back to the effects of the chemical bonding. For small layer thickness (impact number $\Omega \lesssim 100$) deviations of the screening function $q(\chi)$, taken by Moliere as a basis of his theory, result from the calculated changes in the total scattering distribution, which could be detected for $10 \lesssim \Omega \lesssim 100$ in the first approximation by an increase of the Moliere parameter B. This depends on the slope of $q(\chi)$ in the vicinity of the screening angle χ_a. For the case of larger values of the development parameter $a = z\,Z/137\,\beta$ an estimation of this increase of B was given. In the multiple and single scattering range the corrected Moliere distribution leads to large scattering intensities. (tr-auth)

15007 THE NON-LINEAR SPINOR THEORY OF ELEMENTARY PARTICLES. K. Ladanyi (Hungarian Academy of Sciences, Budapest). Z. Naturforsch., 16a: 79-91(Jan. 1961). (In German)

A unified nonlinear theory of elementary particles is introduced and analyzed. The convergence problem of the "new Tamm-Dancoff method" is studied. An approximation method is given for the solution of the convariant equation of the propagator neglecting the four-point and higher correlations. The solution fulfilling certain general physical requirements is taken in a generalized non Touschek-invariant spectral form (the Källen-Lehmann spectral form is a special case) and the integral equation of the weight function is derived. It is shown that, in case of a VA coupling a two component neutrino singularity in the commutator is consistent with equations of motion. The basic ideas of a Touschek invariant theory are studied. The field of elementary particles is a Ψ isodoublet-spinor, the interaction is an isoscalar VA coupling. The form of the commutator excludes for Ψ the possibility of the P and isoinvariant initial conditions. The condition for the non-zero eigenvalue of the total Touschek-charge and for the nonvanishing rest mass is discussed. It is further shown that the covariant two-body equation has a photon-type solution and that the charge of the neutral particles is zero. Finally a possibility for the construction of different elementary particle states is given. (auth)

15008 THE EFFECT OF THE TWO-PARTICLE SPIN-ORBIT INTERACTION AND THE ANGULAR DISTRIBUTION ON THE POLARIZATION OF NEUTRONS ELASTICALLY SCATTERED ON DEUTERONS. Asok K. Bose (Max-Planck-Institut für Physik und Astrophysik, Munich). Z. Naturforsch., 16a: 95-112(Jan. 1961). (In German)

The effect of the supplementary spin-orbit interaction on the elastic scattering of neutrons on deuterons was investigated by consideration of the Pauli principle with two approximation methods. The scattering formula of the Born approximation is transformed into a trace expression. It is then shown that the spin-orbit and central force do not interfere, the spin-orbit force produces no contribution to forward scattering, and there is no polarization. Under the assumption of Gaussian dependence of the interactions, it is numerically indicated that the contributions of the spin-orbit force to the angular distributions (E_{lab} = 50 or 100 Mev) are in general without significance. The coupled equation for the radial function is then derived in the "no polarization" approximation. It is proved that the orbit constituent of the direct spin-orbit force through a potential averaged over the wave function of the deuteron and the effect of the orbit constituent of the spin-orbit force exchange are essentially different from the direct spin-orbit force and the interchange-central force. (tr-auth)

15009 ELASTIC AND INELASTIC SCATTERING OF ELECTRONS BY SILVER FOILS. J. Geiger (Technische Universität, Berlin). Z. Physik, 161: 243-51(1961). (In German)

The energy and angular distributions of fast electrons after passage through a silver foil were determined with an electrostatic spectrograph. The causes for the continuous elastic background occurring outside the crystal reflex are discussed. The energy losses found, lines at 3.6 and 7.5 ev and a band at about 20 ev, are explained both as plasma oscillations according to the Bohm and Pines plasma theory and as band-band transitions. (tr-auth)

15010 ENERGY LOSS OF 25-KEV ELECTRONS IN ATOMIC HYDROGEN. H. Boersch, J. Geiger, and H.-J.

Reich (Technische Universität, Berlin). Z. Physik, 161: 296-309(1961). (In German)

The energy loss of 25-kev electrons in thermally dissociated atomic hydrogen was experimentally determined. The results obtained agree in magnitude and intensity with the results to be expected from the Bethe theory for the excitation of level transitions of atomic hydrogen by electron collision. (tr-auth)

15011 FLUCTUATION PROBLEM IN ELECTROMAGNETIC CASCADES. S. K. Srinivasan (Indian Inst. of Tech., Madras). Z. Physik, 161: 346-52(1961). (In English)

The fluctuation problem in electromagnetic cascades is examined in the light of the new approach to cascade theory, and it is shown that the method originally proposed by Janossy is best suited to deal with it. A method of obtaining explicit expressions for the second moment of the distribution is given, and the differential equations obtained by this method turn out to be simpler and amenable to numerical computation. (auth)

15012 IMPROVED MEASUREMENT OF THE SPECTRUM OF X-RAY BREMSSTRAHLUNG OF THIN ANTICATHODES AT 34 Kev. H. Kulenkampff and D. Röss (Universität, Wurzburg, Ger.). Z. Physik, 161: 424-7 (1961). (In German)

The investigations of Amrehn, Kerscher, and Kulenkampff were extended and improvements in the research apparatus and the measurement devices, as well as in the controls used, were made. It is shown that the earlier measurements were markedly adulterated. The spectrum decreases from the limiting energy k_0 to smaller energies k more sharply than was previously assumed (in the emission direction 0 and 180°). The origin of this effect lies in the previously undervalued frequency of the "pile-up" of small pulses. In the new measurements the pile-up probability is sufficiently small. (tr-auth)

15013 POLARIZATION OF THE X-RAY BREMSSTRAHLUNG OF THIN ANTICATHODES AT 35 AND 45 Kev. H. Kulenkampff and W. Zinn (Universität, Wurzburg, Ger.). Z. Physik, 161: 428-38(1961). (In German)

The pattern of the polarization order in the spectrum of thin Al_2O_3 foils at 35 and 45 kev and of Au foils at 35 kev was restudied at 90° to the primary electron beam using the Barkla method (scattering under 90° on Be) and proportional counters. There was a drop from the limiting energy k_0 to smaller energies k, which in the case of Al_2O_3 can be followed to negative values, with zero passage about $k/k_0 = 0.15$. In Au the polarization order at the limiting energy k_0 is lower and the drop to smaller k flatter. As far as present theories permit assumptions, there was satisfactory agreement. Small variations are plausible through approximations of theoretical formulas. (tr-auth)

15014 ON THE DIFFRACTION OF ELECTROMAGNETIC WAVES ON AN IDEAL CONDUCTING FLAT RING. G. A. Grinberg and E. N. Kolesnikova (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 13-17(Jan. 1961). (In Russian)

The diffraction of a plane wave in an ideally conducting plane annulus (normal incidence) was analyzed with the assumption that the inside radius of the ring and its width b-a are considerably larger than the wavelength λ. Asymptotic solutions are derived (with an accuracy of $1/\delta^2$, where δ is the smallest of the two numbers $\gamma = 2\pi a/\lambda$ and $\gamma' = 2\pi(b-a)/\lambda$) of integral equations for the imposed shadow currents, facilitating the resolution of complete currents. (tr-auth)

Neutron Physics

15015 (GA-2036) SPATIALLY DEPENDENT NEUTRON SPECTRA. J. R. Beyster, J. L. Wood, and H. C. Honeck (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 20, 1961. Contract AT(04-3)-167. 15p.

Presented before the American Nuclear Society Meeting in San Francisco, California, December 14, 1960.

A discussion is given of the objectives of the program established to develop methods for measuring and predicting infinite medium neutron spectra. Primary emphasis was placed on studies of moderation in water, with secondary emphasis in graphite, beryllium oxide, zirconium hydride, and polyethylene. Typical infinite medium results are shown for the hydrogen atom in cadmium sulfate solutions. Two geometries for stab-lattice spectra measurements are illustrated. The axial flux distribution of 1.4-ev neutrons in a 4-in.-thick tank of water poisoned to 6 barns per H atom is given. The results are shown graphically for the calculation of the spectrum at the peak in the flux distribution using diffusion theory. Leakage spectra are included for 4-in.-thick boric acid and water slabs, separately. (B.O.G.)

15016 (KAPL-M-DTG-1) A DESCRIPTION OF THE KERNEL OUTPUT. D. T. Goldman and F. D. Federighi (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 18, 1961. 7p.

KERNEL, a digital computer program, is used to compute the cross-section for the scattering of low energy neutrons from water. Presented is a discussion of the theory underlying the program and a description of the format of the output from the program. The output appears in the general form: $(d^2\sigma/d\lambda\, dE_f)$, and the differential cross section; $(d\sigma_l/dE_f)$, the various Legendre moments of the cross-section; and σ, the total cross section. Included is the differential cross section in the momentum and energy transfer representation to facilitate direct comparison with experimental data. (auth)

15017 (NRL-5592) DETERMINATION OF THE J-VALUES OF S-TYPE NEUTRON RESONANCES BY MULTIPLE SCATTERING. A. W. Sáenz and S. Podgor (Naval Research Lab., Washington, D. C.). Dec. 15, 1960. 12p.

Selected results are presented of a Monte Carlo investigation of the multiple scattering of polarized and unpolarized neutrons by s-type resonances having $\Gamma\gamma/\Gamma \ll 1$, for the case of polarized and unpolarized targets with plane-parallel slab geometry. For simplicity, the resonances for which Γ was so large that it was unnecessary to consider Doppler corrections were considered. The results for the 337, 132, and 290 ev resonances of Mn^{55}, Co^{59}, and Ga^{71}, respectively, strongly suggest the conclusion that data from such measurements can be employed to determine, in principle, the J-values for a number of resonances for which Γγ and Γ are moderately well-known and satisfy the conditions specified above. From the standpoint, of present experimental techniques, the most interesting results concern unpolarized neutrons incident on unpolarized targets. (auth)

15018 DOPPLER EFFECT IN NEUTRON ABSORPTION RESONANCES. A. W. Solbrig, Jr. (Argonne National Lab., Idaho Falls, Idaho). Am. J. Phys., 29: 257-61(Apr. 1961).

The theory of Doppler broadening of spectral lines by thermal atomic motion is well known. This theory can be applied to neutron resonances because of similarity in shape of spectral and nuclear lines. Since such application

is not completely satisfactory, different derivations were worked out for the nuclear case. The more direct of these derivations is reviewed, and the technological importance of the nuclear Doppler effect is discussed. (auth)

15019 USE OF THE MOMENTS METHOD FOR CALCULATING THE SPATIAL AND ENERGY DISTRIBUTIONS OF THE NEUTRON FLUXES PROVIDED BY POINT AND TWO-DIMENSIONAL SOURCES IN AN UNBOUNDED MEDIUM. A. R. Pitsyn. Atomnaya Energ., 10: 117-26 (Feb. 1961). (In Russian)

The spatial and energy distributions of neutron fluxes from point and two-dimensional sources in an infinite medium are calculated. The neutron flux $\psi(x,E)$ is sought in the expression $\psi(x,E) = \sum_{i=1}^{n} a_i(E)K[b_i(E)x]$. The appearance of the K(x) function is selected arbitrarily on the basis of physical considerations. The 2N of the spatial moment of the $\psi(x,K)$ function is used for finding the 2N for the parameters a_i and b_i. The distribution of neutron flux in hydrogen and water was found. The data on distribution in water are correlated with experimental data comparison with the precise solution found by G. Wick (Phys. Rev. 75, 738(1949)) for the case of neutron delay by hydrogen showed that the suggested method enables one to find the spatial neutron distribution by four moments at distances of up to 20 times the length of a free trajectory. (tr-auth)

15020 A GENERATOR PRODUCING A STRONG FLUX OF NEUTRONS OF 14 OR 2.5 Mev. V. I. Petrov. Atomnaya Energ., 10: 163-4(Feb. 1961). (In Russian)

Descriptions are given of a neutron generator with D-T neutron intensity over 10^{11} neutrons/sec and D-D neutrons over 10^9 neutrons/sec. The specifications of the ion source are as follows: deuterium ion flux from the source, is 9 to 11 ma; content of D_2O, ~85%; deuterium consumption, ~53 cm^3/h; the length of ion drawing system, 10 mm; the channel diameter, 3.5 mm; prolate force, 7 to 8 kev; the power used by the generator, 500 to 600 N; and frequency, 25 Mhz. The operating data of the installation showed that the maximum intensity for neutron flux at 14 Mev is 5.3×10^{11} neutrons/sec; at 2.5 Mev, 5.0×10^9 neutrons/sec. (R.V.J.)

15021 EFFECTS OF INELASTIC SCATTERING IN URANIUM ON THE MODERATION LENGTH FOR NEUTRONS IN WATER. B. A. Levin, E. V. Marchenko, and D. V. Timoshuk. Atomnaya Energ., 10: 177-9(Feb. 1961). (In Russian)

The effects of inelastic scattering of neutrons in uranium on the slowing down distance in pure water were measured in spherically symmetric geometry. The source (16 mm in diameter) imitating the neutron fission spectrum was concentrically surrounded by spherical 2-mm-thick layers of metallic uranium depleted in U^{235}. (R.V.J.)

15022 ON SOME INTERCOMPARISONS BETWEEN CALIBRATED NEUTRON SOURCES. G. P. Felcher (CISE, Milan), E. Germagnoli, M. Musci, and G. Poletti. Energia nucleare (Milan), 8: 105-6(Feb. 1961). (In English)

Intercalibration measurements are reported for the CISE Raα + Be neutron source; its thermal neutron output rate is compared with the outputs of the Basel and Stockholm sources. The intercalibration measurements are compared with absolute neutron output rate measurements. Effects of detectors of Au, Mn, and H are discussed. (T.F.H.)

15023 INVESTIGATION OF THE ALBEDO OF THERMAL NEUTRONS. J. Csikai and A. Daroczy (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Magyar Tudományos Akad. Atommag Kutató Intezéte (Debrecen). Közlemények, 2: No. 3, Suppl., 10p.(1960). (In English)

The albedo value for paraffin was determined on the basis of the definition of "experimental albedo" introduced by Amaldi and Fermi. The value thus obtained was $\beta = 0.855 \pm 0.003$. The value calculated for the given experimental arrangement by the diffusion-theory was $\beta = 0.785 \pm 0.012$. The reasons for deviation of the two values and possibilities for their comparison were investigated. A method was elaborated to experimentally determine the albedo defined by the diffusion-theory. (auth)

15024 THE EFFECT OF DIFFUSION UPON THE INITIAL PHASES OF THE THERMALIZATION OF NEUTRONS. Noel Corngold and Larry Zamick (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng., 9: 367-9(Mar. 1961). (BW-5022)

The effect of diffusion on the slowing-down spectrum of neutrons in the upper portion of the thermal regime is discussed. In a typical case, the perturbation due to diffusion is comparable to the difference between bound atom and free atom spectra, in the energy range $E > 0.1$ ev. (auth)

15025 SLOWING-DOWN TIME OF NEUTRONS IN WATER. J. A. DeJuren (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 9: 408-9(Mar. 1961).

The slowing down time of high-energy neutrons to the cadmium cut-off energy in a moderator having 1/v absorption is obtained from a measurement of the cadmium ratio with a thin 1/v detector. For 1/v epicadmium and thermal absorption, the probability of neutron capture is independent of velocity and is given by $-dn/n = dt/\tau_{th}$ where τ_{th} is the mean thermal lifetime. Integration of the formula is shown and an example is discussed. (N.W.R.)

15026 EFFECT OF INTERFERENCE BETWEEN RESONANCE AND POTENTIAL SCATTERING ON RESONANCE ABSORPTION. George I. Bell (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng., 9: 409-10 (Mar. 1961).

Numerical solutions of the integral equation for the neutron flux in an infinite homogeneous medium are given. The results for some U^{238} unbroadened Breit Wigner resonances and a Bi resonance with hydrogen as a moderator are shown. In each case the resonance absorption probability was calculated both with and without interference. Interference is physically important in these resonances because the scattering is increased for energies above the resonance peak and is decreased below the resonance peak. Therefore the effect is to increase scattering into the resonance and to decrease scattering out. Hence interference tends to trap the neutrons in the energy region of the resonance. (N.W.R.)

15027 MEASUREMENT OF THE DIFFERENTIAL SCATTERING CROSS SECTION AND THE MEAN ENERGY VARIATION IN THE SCATTERING OF SLOW NEUTRONS ON WATER AND ICE. Christian Reinsch and Tasso Springer (Technische Hochschule, Munich). Z. Naturforsch., 16a: 112-16(Jan. 1961). (In German)

Neutrons with energies of 0.039 and 0.078 ev were scattered on thin layers of water and ice at various temperatures. The angular distribution of the scattered neutrons was determined through a Li^6I scintillation counter with an approximate sensitivity of 100%, and the differential scattering cross section was calculated. There was only a slight variation between water and ice. It comes principally from the contribution of the coherent scattering on ice, which disappears in water. The variation of the mean neutron energy was determined from transmission investigations. A comparison is made with the Nelkin theory. (tr-auth)

15028 DIGITAL COMPUTATION OF SPACE-TIME VARIATION OF NEUTRON FLUXES IN A COMPLEX REACTOR CONFIGURATION. E. L. Wachspress (Knolls Atomic Power Lab., Schenectady, N. Y.). p.171-7 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

Time-dependent neutron diffusion equations have been solved for reactor models of varying degrees of complexity. Space-time separability is usually assumed. A method is described for solving non-separable kinetics problems with the aid of a digital computer. A multichannel synthesis technique is first applied to reduce a complex reactor mockup to one with relatively few space nodes in each plane perpendicular to the coolant flow. Direct inversion of the group diffusion difference operator is then accomplished by inverting at each plane a matrix of rank equal to the number of energy groups times nodes in the plane. The complexity of problems solved may be adjusted to conform to the available digital computer. Application of the Perron-Froebenius theory of non-negative matrices provides a firm mathematical foundation for the numerical analysis. Simultaneous solution of all energy groups virtually eliminates the need for the fission source iteration employed in most group diffusion calculations. The kinetics equations are non-linear. To make the problem tractable it is assumed that the neutron flux varies linearly over each time step. An implicit integration of linear equations combined with iteration on flux-dependent coefficients is then used to determine neutron fluxes at the end of the time step that are consistent with the assumed linear variation within the time step. Stability of the numerical procedure is related to stability of the reactor. Rapid flux transients encountered in accident studies require special consideration. Time-dependent perturbation theory is applied, although modifications of the usual quantum mechanical equations are needed to allow for the non-Hermitian character of the group diffusion operator. Little difficulty is encountered in obtaining higher modes when all groups are solved simultaneously. The multichannel synthesis neutron flux model lends itself readily to combination with thermal and hydraulic calculations of the overall reactor system. This approach to reactor calculations is quite general and can lead to complex programs requiring high-speed computers with large memory capacities. The technique may, however, be applied to much simpler models where small computers are adequate. (auth)

15029 SLOWING DOWN OF NEUTRONS IN HETEROGENEOUS REACTORS. W. Matthes, T. Springer, and W. Urich (Technische Hochschule, Munich). p.237-41 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A program for the computer PERM of the Technische Hochschule in Munich is described by which the Fermi-age and the spatial distribution of fast and slow neutrons are determined. A Monte-Carlo method was used. All relevant processes, elastic and inelastic scattering, fast and intermediate fission, and capture, are taken into account. The results of the computations are discussed. (auth)

15030 PULSED NEUTRON THEORY ACCORDING TO THE HEAVY GAS MODEL. J. Virkkunen (Inst. of Tech., Helsinki). p.275-86 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

The neutron thermalization near thermal energies can be calculated approximately on the basis of the heavy gas model. In this model one disregards the effects of the chemical bonds and takes the thermal motion of the moderator atoms into account in an approximate manner. The resulting equations are mathematically rather simple and contain few physical constants, so that these equations can be applied easily in very common situations. The heavy gas model has been applied to the calculation of the energy dependent neutron flux in a pulsed neutron experiment. The neutron flux is represented as a series in orthogonal functions. The space-dependent eigenfunctions satisfy the equation $\nabla^2 y(\vec{r}) + B_k^2 y(\vec{r}) = 0$, and the energy-dependent eigenfunctions are the associated Laguerre-polynomials of the order one multiplied by Ee^{-E}. E is the neutron energy in units of kT. The coefficients of the series expansions are calculated from infinite groups of algebraic equations. These coefficients can be calculated numerically on digital computers or iteratively also on a desk calculator. The matrix elements in the equations are to be calculated numerically with the exception of some simple cases. The decay constant of the fundamental space-mode is calculated in a separate chapter. This constant can be brought into the form $\lambda = \lambda_a + DB^2 - CB^4$, where C is the diffusion cooling coefficient. The formula for the diffusion cooling coefficient is extracted from the series expansion. Numerical values are calculated for the diffusion cooling coefficient in graphite, beryllium, and heavy water. As regards graphite and beryllium, the agreement with measured values is good, within experimental errors. In the case of heavy water there is some ambiguity in the definition of the parameters of the heavy gas model. With suitably chosen parameters the calculated and measured values can be brought into agreement. (auth)

Nuclear Properties and Reactions

15031 (AE-39) THE DEPENDENCE OF THE RESONANCE INTEGRAL ON THE DOPPLER EFFECT. J. Rosen (Aktiebolaget Atomenergi, Stockholm). Dec. 1960. 67p.

The Doppler sensitive contributions to the neutron resonance integral for metal and oxide cylinders were calculated using tables compiled by Adler, Hinman, and Nordheim. The temperatures 20, 200, 350, 500, and 650°C were investigated for the pure metal and 20, 300, 600, 900, and 1200°C for the oxide. Contributions from the separate resonances in the resolved region and for certain energies in the unresolved region are accounted for in detail. Integration over adequate statistical distributions was carried out for the resonance parameters in the unresolved region. The increase in the resonance integral at elevated temperatures due to the Doppler effect is given in tables and diagrams. (D.L.C.)

15032 (AERE-NP/R-2086) THE TOTAL CROSS-SECTION FOR INELASTIC INTERACTIONS OF 14 MEV NEUTRONS IN NATURAL URANIUM. J. Kirkbride and D. I. Page (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 22, 1956. 11p.

The multiplication and transmission of neutrons by spherical shells of natural uranium surrounding a point source of 14-Mev neutrons were measured. A value of the total inelastic cross-section was calculated, and the quantity $\sigma_{(n,2n)} + 2\sigma_{(n,3n)} + (\bar{\nu} - 1)\sigma_f - \sigma_c$ was derived. (auth)

15033 (AERE-NP/R-2086(Suppl.1&2) TWO SUPPLEMENTS TO REPORT A.E.R.E. NP/R 2086. I. A REDETERMINATION OF THE TOTAL INELASTIC CROSS SEC-

TION OF NATURAL URANIUM FOR 14 MEV NEUTRONS. II. A DETERMINATION OF THE TOTAL INELASTIC CROSS SECTION OF NATURAL URANIUM FOR NEUTRONS OF ENERGIES FROM 4 TO 14 MEV. J. Kirkbride (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 1957. 14p.

Corrections for thick shell effects reduced the calculated total inelastic cross section σ_i to 2.75 ± 0.04 barns for 14-Mev neutrons. The cross sections for 4- to 14-Mev neutrons were estimated as follows: σ_i = 2.76 ± 0.15 barns at 5 to 14 Mev and decreases to ~2.3 barns at 3 to 5 Mev. (B.O.G.)

15034 (AERE-R-3593) THE MEASUREMENT OF THE SCATTERING LAW FOR A MODERATOR. P. A. Egelstaff (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 14p.

The problems and methods associated with the measurement of scattering laws are discussed. An experimental arrangement consisting of phased choppers and multiple detecting apparatus is considered the most favorable method and is discussed. (auth)

15035 (ANL-6312) FRACTIONAL PARENTAGE COEFFICIENTS IN INTERMEDIATE COUPLING. Dieter Kurath (Argonne National Lab., Ill.). Mar. 1961. Contract W-31-109-eng-38. 18p.

Fractional parentage coefficients are obtained which connect certain low-lying states in the 1p shell without the necessity of referring to either an LS or jj representation. The possibility of doing this algebraically is based on the generator method of producing the wave functions of these states. (auth)

15036 (ARL-TN-60-144) THE ENERGY DISTRIBUTION OF ELECTRONS FROM IONIZING COLLISIONS OF HEAVY PARTICLES. Period Covered June 1, 1958–August 31, 1960. H. W. Berry (Syracuse Univ., N. Y.). Sept. 1960. Contract AF33(616)-5741. 52p. (AD-245856)

The energy distribution of electrons produced in ionizing collisions of ions and fast atoms or molecules with the atoms or molecules of a gas at rest were measured for hydrogen, nitrogen, argon, and helium. The energy of the incident particles ranged from 0.30 to 3.0 kev. The electrons released at 90° with the incident ion or atom beam were analyzed in an electrostatic energy selector which consisted of 90° segments of coaxial cylinders. The use of a fine wire grid in the region in which ionization occurs allowed a positive differentiation to be made between the ionization electrons and secondary electrons from any metal surfaces. For the molecular and atomic ions and neutral particles of hydrogen the yield decreased rapidly from a maximum at zero energy to an energy of about five electron volts and then more slowly afterward. Little difference existed between the distributions for charged and uncharged atomic and molecular incident particles. The results in nitrogen were similar to those in hydrogen. An increase in the energy of relative motion increased the over-all yield as well as the relative number of fast electrons. Argon ions and neutral atoms in argon, however, produced a spectrum in which there was at first a rapid decrease in the yield with increasing electron energy, but which was followed by a plateau and a second maximum. A similar distribution was observed for helium except that the ion and neutral atom second maximum were at much different electron energies. Generally these distributions were collision energy independent except for an increase in the over-all yield. (auth)

15037 (CU(PNPL)-207) LONGITUDINAL POLARIZATION OF ELECTRONS FROM Pm^{147}. (thesis). Chellis Chasman (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Feb. 14, 1961. Contract AT-30-1-GEN-72. 119p.

The longitudinal polarization of the electrons emitted in the decay of Pm^{147} was investigated by the method of Mott scattering. A straight line spectrometer using crossed electric and magnetic fields was built to analyze the energy of the electrons and to rotate their spin relative to their momentum from zero to 2π radians. The polarizations obtained for a 90° spin rotation are in fair agreement with that expected on the basis of the two component theory of the neutrino. For greater rotations higher field strengths are required, and it is suspected that the fringing fields introduce asymmetries not adequately corrected for by the normalizing aluminum foil. A discussion is given of the validity of this type normalization and of other errors that might arise in determining the polarization by Mott scattering. (auth)

15038 (GACD-1951) RANGE OF RECOIL ATOMS. Quarterly Status Report No. 5, October 1, 1960 through December 31, 1960. V. A. J. van Lint (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 13, 1961. Contract AF33(616)-6795. 16p.

Further measurements were made of the range of atoms recoiling from (γ,p) reactions. Thin film data were analyzed to indicate the extent of the range distribution for atoms recoiling out of thin films of copper evaporated on pure aluminum foils. The spectra of particles emitted in the photonuclear reactions were calculated. Data resulting from recoil studies of (γ,p) and (γ,α) reactions on Cd, Cu, Zr, Ti, and Ni are presented. Preparation of Cu–Ag and Cu–Au alloys was continued. (M.C.G.)

15039 (JINR-P-247) MATERIALY SOVESHCHANIYA PO PRIMENENIYU RADIOKHIMICHESKIKH METODOV IZUCHENIYA YADERNYKH REAKTSII 1 β-, γ-SPEKTROSKOPII NEITRONODEFITSITNYKH YADER. PART II. Deformirovannye Yadra V Oblasti Nd-Os. (On the Application of Radiochemical Methods of Investigation of Nuclear Reactions and β and γ Spectroscopy of Neutron Deficient Nuclei. PART II. DEFORMED NUCLEI IN THE REGION Nd-Os). B. S. Dzhelepov and L. D. Peker (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1958. 77p.

The 660-Mev proton beam from the Dubna synchrocyclotron was used to produce rare earth isotopes which were then separated chemically from the target and from each other. The following methods were used in the investigation of the rare earth nuclides; mass spectroscopy, γ-ray spectrometry with various instruments, γ-γ coincidence measurements, β^+ spectroscopy with various instruments, conversion line spectroscopy, electron coincidence measurements, and x-ray spectrometry. The region Nd-Os was thus investigated. A brief review is given concerning the theory of deformed nuclei, followed by tables of rotational levels, half lives, high-lying levels, spins, single particle levels, transition multi-polarities, and deformation parameters. These are also presented systematically as a function of atomic number by means of graphs. A thorough review of nuclear structure in this part of the periodic table is given. (T.T.T.)

15040 (LA-2461) IBM 704 PROGRAMS FOR UNFOLDING COMPLEX GAMMA-RAY SPECTRA. William B. Strickfaden and Robert M. Kloepper (Los Alamos Scientific Lab., N. Mex.). Sept. 1960. Contract W-7405-ENG-36. 126p.

Four FØRTRAN-II programs for use on an IBM 704 were written for analysis of the complex gamma-ray spectra

usually encountered in the studies of decay schemes of radioactive nuclides. Each of the programs is described and an example of the use of each is given. (auth)

15041 (LA-2493) (n,2n), (n,p), AND (n,α) EXCITATION FUNCTIONS OF SEVERAL NUCLEI FROM 7.0 TO 19.8 MEV. B. P. Bayhurst and R. J. Prestwood (Los Alamos Scientific Lab., N. Mex.). Dec. 1960. Contract W-7405-ENG-36. 50p.

(n,2n) cross sections for Sc^{45}, Ti^{46}, Ni^{58}, Cu^{65}, Ge^{70}, As^{75}, Rb^{85}, Rb^{87}, Sr^{84}, Y^{89}, Zr^{90}, Nb^{93}, Ag^{107}, Cd^{116}, In^{115}, Sn^{112}, Sb^{121}, Sb^{123}, Ta^{181}, Au^{197}, Tl^{203}, and Th^{232} are plotted at incident energies from 12 to 19.76 Mev. (n,p) cross sections for Sc^{45}, As^{75}, Sr^{86}, Y^{89}, Zr^{90}, Ag^{109}, Cd^{111}, and Au^{197}, and (n,α) cross sections for Al^{27}, Sc^{45}, As^{75}, Y^{89}, Zr^{92}, Zr^{94}, Nb^{93}, Cd^{112}, Sn^{118}, and Au^{197} are plotted at incident energies of 7.0, 8.0, 12, 13.3 to 14.9, 16.5, 18.0 and 19.8 Mev. (auth)

15042 (NYO-2243) MEASUREMENT OF THE "ISOTOPE EFFECT" IN THE NUCLEAR CAPTURE OF NEGATIVE MUONS BY CHLORINE AND INVESTIGATION OF THE VALIDITY OF THE FERMI-TELLER "Z-LAW" IN AgCl. (thesis). Walter J. Bertram, Jr. (Carnegie Inst. of Tech., Pittsburgh). Sept. 1960. Contract AT(30-1)-882. 55p.

Negative muons were used to study some of the interactions of these particles in various materials. Information on the interactions was obtained by analysis of the time distribution of the electrons resulting from the decay of muons brought to rest in the material. The isotope effect in the nuclear capture of negative muons was studied in separated isotopes of chlorine. The ratio of the capture rates in the two stable isotopes was determined to be $\lambda_c(Cl^{37})/\lambda_c(Cl^{35}) = 0.694 \pm 0.034$. This effect is larger than that of the ratio of 0.782 predicted by the general theory of Primakoff. Studies were also made of the validity of the Fermi-Teller Z-law, which predicts the probability of a negative meson becoming bound to a particular atomic species when the mesons are brought to rest in a chemical compound. These studies indicate that in AgCl, the muons are captured in equal numbers by the Ag and Cl atoms and not in the proportions predicted by the Z-law. The lifetimes of negative muons were measured in Ag, Cl, and F and found to be 91.5 ± 2.3 nsec, 0.437 ± 0.022 μsec, and 1.217 ± 0.080 μsec, respectively. (D.L.C.)

15043 (SUI-60-16) INVESTIGATIONS OF THE Al^{27} (p, γ)Si^{28} REACTION (thesis). John Ignatius Valerio (Iowa. State Univ., Iowa City). Feb. 1961. 158p.

The $Al^{27}(p,\gamma)Si^{28}$ reaction at the 226-, 294-, 326-, 405-, and 630-kev resonances was investigated. Gamma spectra were studied with a large 5 × 6 in. NaI(Tl) crystal scintillation detector. At the 326- and 405-kev resonances spectra were taken with a high resolution three crystal pair spectrometer, which permitted accurate energy identification. Coincidence studies of the radiation served to resolve the complex cascade decay of the capture states. Double correlations (p, γ), (p, X, γ), and (p, X, X, γ), and triple correlations (p, γ, γ), (p, X, γ, γ), and (p, γ, X, γ) at the 326-, 405-, and 630-kev resonances have established the spin sequences involved in the main double and triple cascades observed. The symbol "X" denotes an unobserved intermediate radiation. Spins and parities of various levels in Si^{28} were determined. (auth)

15044 (TID-12131) HALF-LIVES OF ^{117}In AND ^{117m}In. N. D. Dudey and T. T. Sugihara (Clark Univ., Worcester, Mass.). Mar. 14, 1961. Contract AT(30-1)-1930. 8p.

Half lives were determined for In^{117} and In^{117m} as 38.0 ± 1.3 min and 1.93 ± 0.05 hr, respectively. The methods for the production and separation of the indium isotopes from cadmium, which was irradiated with 5- and 14-Mev deuterons, are described. The 565-kev gamma ray of indium was counted. (B.O.G.)

15045 (TID-12168) ELASTIC SCATTERING AND REACTIONS OF PROTONS ON ARGON-40. A. C. L. Barnard and C. C. Kim (Iowa. State Univ., Iowa City). [1960?]. 21p.

Thin targets of natural argon gas were bombarded with protons with energies between 0.8 and 3.5 Mev. Differential cross sections were measured at three angles for elastic scattering and for the reactions $Ar^{40}(p,p'\gamma)$ and $Ar^{40}(p,\alpha)$. Many anomalies were observed in the elastic scattering cross section, the strongest being at 1.88, 2.45, and 3.4 Mev. $j\pi = 3/2-$ and $1/2+$ were assigned to the levels corresponding to the first two strong anomalies. The anomalies corresponding to the previously reported $Ar^{40}(p,\gamma)$ resonances were too small to be detected. In the range of incident proton energy between 2.4 and 3.4 Mev, there were about 40 resolved or partly resolved resonances in the alpha particle yield. (auth)

15046 (TID-12352) EXCITATION FUNCTIONS FOR LITHIUM-6 INDUCED REACTIONS ON ALUMINUM-27. Inge-Maria Ladenbauer, Ivor L. Preiss, and Carl E. Anderson (Yale Univ., New Haven). [1961]. 19p.

Excitation functions for a number of Li^6-induced reactions on Al^{27} were studied using stacked foil techniques and the Li^6 ion beam from the Yale Heavy Ion Accelerator. Excitation functions corresponding to radioactive residual nuclei P^{32}, P^{30}, Si^{31}, Al^{29}, Al^{28}, Mg^{27}, Na^{24} and Na^{22} were measured in the Li^6 range from 1 to 63.3 Mev. The data strongly suggest that the P^{32}, P^{30}, and Si^{31} result from compound system processes and the Na^{22} and Na^{24} from a predominant direct knockout process. In the cases of Al^{28} and Al^{29} both compound system and direct pickup reaction amplitudes contribute to the reaction yield. (auth)

15047 (UCOL-P-504) STUDIES OF GAMMA RAYS FROM NEUTRON INELASTIC SCATTERING AND TABULATED VALUES OF GAMMA RAY EXCITATION CROSS SECTIONS FOR NEUTRON EXCITATION. David A. Lind (Colorado. Univ., Boulder) and Robert B. Day (Los Alamos Scientific Lab., N. Mex.). [nd]. 16p.

The cross sections listed are values taken from curves representing the best average of the experimental data. The cross sections refer to observed gamma-ray yield in every case and are given in millibarns and corrected to 100% isotopic abundance of the element, unless noted otherwise. (auth)

15048 (UCRL-9394) $N^{15}(p,p2n)N^{13}$ REACTION INDUCED BY PROTONS OF ENERGY 0.4 TO 6.2 BEV (thesis). Linda Chang Sah (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1960. Contract W-7405-eng-48. 36p.

N^{14} and N^{15} were bombarded with protons in the energy range 0.4 to 6.2 Bev. Measured values of the absolute cross sections for $N^{14}(p,pn)N^{13}$ are 6 mb over the stated energy range, which agree with and supplement the previous measurements up to 3.0 Bev. The (p,pn) yield is higher than the (p,p2n) yield by a factor of 2 to 3 in the entire energy range of interest. (auth)

15049 (UCRL-9480) ATOMIC BEAM RESEARCH ON THE SPINS, HYPERFINE STRUCTURES, AND MOMENTS OF K^{43}, Y^{90}, La^{140}, AND Lu^{177}. (thesis). Fred Russell Petersen (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 21, 1960. Contract W-7405-eng-48. 160p.

The atomic beam magnetic resonance method was used to

investigate the hyperfine-structure separations of radioactive isotopes K^{43}, Y^{90}, La^{140}, and Lu^{177}. Except for K^{43}, which was produced by the reaction $Ar^{40}(\alpha,p)K^{43}$ with the Crocker 60-in. cyclotron at Berkeley, all isotopes were reactor-produced by (n,γ) reactions. K^{43} was investigated in the ^2S electronic ground state with the following results: $I = 3/2$, $\Delta\nu = 192.64(5)$ Mc/sec, $|\mu_I| = 0.163(2)$ nm; $|\mu_I|$ was obtained with the aid of the Fermi-Segrè formula from the zero-field hyperfine-structure separation, $\Delta\nu$, and the known constants of K^{39} or K^{41}. The remaining isotopes were investigated in both the $^2D_{3/2}$ and the $^2D_{5/2}$ electronic states. These measurements yielded the following spins and hyperfine-structure interaction constants: for the $^2D_{3/2}$ electronic state $I = 2$, $a = -169.749(7)$ Mc/sec, $b = -21.602(27)$ Mc/sec for Y^{90}, and $I = 7/2$, $a = 194.84(2)$ Mc/sec, $b = 1466.71(12)$ Mc/sec for Lu^{177}. In the $^2D_{5/2}$ electronic state $I = 2$, $a = -85.258(6)$ Mc/sec, $b = -29.716(38)$ Mc/sec for Y^{90} and $I = 7/2$, $a = 147.17(1)$ Mc/sec, $b = 1805.93(14)$ Mc/sec for Lu^{177}. The spin $I = 3$ was measured in both electronic states for La^{140}. The uncorrected nuclear magnetic moment of Y^{90} calculated from the hyperfine structure by use of the magnetic moment and interaction constants of Y^{89} was $\mu_I = -1.623(8)$ nm. The sign of the moment was determined from the g_I-dependent $\Delta F = \pm 1$ transitions for which the magnetic field dependence of the frequency was zero at high fields. The uncorrected nuclear electric quadrupole moment of Y^{90} calculated from the interaction constants for both electronic states was $Q = -0.155(3)$ barns. The uncorrected nuclear magnetic moment of Lu^{177} calculated from the hyperfine structure with the aid of the magnetic moment and interaction constants of Lu^{175} was $\mu_I = +2.0(2)$ nm. The sign of the moment was also determined. The uncorrected nuclear electric quadrupole moment of Lu^{177} calculated from the interaction constants for both electronic states was $Q = +5.0(6)$ barns. Because of the large quadrupole moment in Lu^{177}, the zero-field level ordering was inverted, in order of decreasing energy: $^2D_{3/2}$ state: F = 5, 2, 4, and 3, and $^2D_{5/2}$ state: F = 6, 5, 1, 4, 2, and 3. Resonance detection was accomplished by collecting radioactive atoms on sulfur-coated surfaces, which were subsequently counted in continuous-flow methane beta counters. (auth)

15050 (AEC-tr-3972(p.1-57)) RESONANCE SCATTERING OF γ-RAYS ON NUCLEI. B. S. Dzhelepov. Translated from Uspekhi Fiz. Nauk, 62: No. 1, 3-40(1957).

An investigation was made of the resonance scattering of γ rays on nuclei. The relation between the average lifetime of an excited state and its energy width was determined by the uncertainty relation. Cross sections for resonance excitation of nuclei and resonance scattering of γ rays were calculated. Methods of detecting resonance scattering are outlined. Nuclear excitation by γ-irradiation of identical nuclei is described. The possibilities of increasing resonance by heating the source and by mechanically moving the source are discussed. The width of the spectral belt of γ radiation arising from a recoiling nucleus after β decay was determined. Angular distributions of resonantly scattered γ rays were calculated. The possibility of using the Compton effect for observation of resonance scattering was studied. Prospects for the use of resonance scattering of γ rays to study the properties of nuclear states are described. Inelastic resonance scattering was also investigated. (M.C.G.)

15051 DETERMINATION OF THE ABSOLUTE DISINTEGRATION RATES OF LOW ENERGY BETA EMITTERS IN A LIQUID SCINTILLATION SPECTROMETER. Donald L. Horrocks and Martin H. Studier (Argonne National Lab., Ill.). Anal. Chem., 33: 615-20(Apr. 1961).

Integral counting techniques using a liquid scintillation spectrometer for the determination of the absolute disintegration rate of β emitters were extended to the isotopes S^{35}, C^{14}, Sm^{151}, Ni^{63}, Ru^{106}, Pu^{241}, and H^3. Experimental results are compared with those expected from the theory of β decay and the statistical probabilities of scintillation counting. If the shape of the β spectrum is known, the absolute disintegration rate can be determined by integral counting and comparison of the extrapolated integral counting rates for single channel and coincidence systems. Some practical factors involved in obtaining a system with a high counting efficiency for low energy β emitters are discussed. The liquid scintillation spectrometer is shown to be stable, and can determine very small amounts of low energy β emitters. (auth)

15052 STUDY OF THE DECAY SCHEMES OF Tm^{172}, Er^{172}, AND Dy^{166}. R. G. Helmer. Argonne Natl. Lab. News-Bull., 2: No. 2, 3-4(Mar. 1961).

An effort was made to observe effects due to interaction of the two unpaired nucleons in odd-odd nuclei. Levels in odd-odd nuclei may be populated by the beta decay of radioactive even-even nuclides. Tm^{172} and Er^{172} were produced by successive captures of two neutrons in Er^{170}; Dy^{166} was produced by double neutron capture in Dy^{164}. An interpretation of the states in the nuclei produced was very successful. Theoretically there is a deviation from the $I(I+1)$ interval rule, apparently due to an interaction between the unpaired neutron and proton. (N.W.R.)

15053 THE MECHANISMS OF FAST NUCLEON INTERACTION WITH NUCLEI. V. S. Barashenkov, V. M. Mal'tsev, and E. K. Mikhul. Atomnaya Energ., 10: 156-8 (Feb. 1961). (In Russian)

Monte-Carlo calculations of intranuclear cascade for the case of relativistic three-dimensional kinematics considering the multiple production of particles resulting from fast particle reactions with nuclear nucleons confirm the mechanism of intranuclear cascade at 9 Bev and lower. Experimental and theoretical data on the shower particles (0.5- to 9-Bev nucleons and 0.08- to 8-Bev π mesons) and cascade particles (0.03- to 0.05-Bev nucleons and 0.15- to 0.08-Bev π mesons) are tabulated. (R.V.J.)

15054 MEASUREMENT OF THE RADIATIVE-CAPTURE CROSS-SECTION OF I^{127} FOR FAST NEUTRONS. Yu. Ya. Stavisskiĭ, V. A. Tolstikov, and V. N. Kononov. Atomnaya Energ., 10: 158-60(Feb. 1961). (In Russian)

The activation method was used for measuring the radiative-capture cross sections of I^{127} for fast neutrons at 0.02 to 2.5 Mev. The iodine specimens and the U^{235} layer in a fission chamber were irradiated by a flux of fast neutrons. The β activity was measured by a front-window β counter. The radiative capture of neutrons by I^{127} was evaluated considering the U^{235} fission cross section relation to the neutron energy and using the averaged U^{235} fission values. The cross section of I^{127} activation by thermal neutrons was taken as equal to 5.6 ± 0.3 barns. The errors in the measurements of the energy dependence of I^{127} radiative neutron capture cross sections are mostly due to the errors in determining the U^{235} fission cross sections, which were ~25% for $E_n < 60$ kev, ~12% for $E_n = 60$ to 150 kev, and ~8% for higher energy neutrons. The results of measurements are plotted and correlated with published data. The measurements at 0.02 to 1 Mev and at 1 to 1.25 Mev are in good agreement with published data; at 0.15 to 1 Mev the published data are 20% lower. (R.V.J.)

15055 PRODUCTION OF Lu^{178} BY THE $Ta^{181}(n,\alpha)Lu^{178}$ REACTION IN THE NRX REACTOR. P. Glentworth and R. H. Betts (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 39: 381-4(Mar. 1961). (AECL-1166)

A rare earth activity of half life 19 ± 1 min, produced by irradiating tantalum in the fast neutron flux of the NRX reactor was shown to be a lutetium nuclide. The 19 ± 1 min activity was ascribed to Lu^{178} produced by the $Ta^{181}(n,\alpha)Lu^{178}$ reaction. Three γ rays of 450 ± 15 kev, 320 ± 15 kev, and 680 ± 15 kev (very weak) are associated with Lu^{178}. (auth)

15056 THE ROLE OF REPULSIVE CORES IN THE PHOTONUCLEAR EFFECT. John W. Clark (Princeton Univ., N. J.). Can. J. Phys., 39: 385-92(Mar. 1961).

The dipole sum rule is used to investigate the effect of nuclear forces on the integrated photonuclear cross section σ_{int} of a large nucleus, for a Serber potential containing a hard core. A Jastrow wave function is assumed to describe the nuclear ground state, and the first term in the cluster expansion of the resultant expression for σ_{int} evaluated under two different sets of assumptions for the potential and correlation function, corresponding to two different studies of the nuclear matter problem. The presence of a repulsive core in the potential is found to enhance considerably the calculated σ_{int}, compared with the result for a potential without a core which fits the same (low-energy) two-nucleon data. (auth)

15057 STRUCTURE OF THE LINE AT 2892 GAUSS CM IN THE CONVERSION ELECTRON SPECTRUM OF THE ACTIVE DEPOSIT OF RdTh. J. L. Wolfson (National Research Council, Ottawa). Can. J. Phys., 39: 468-70(Mar. 1961). (NRC-6167)

A curious feature of the conversion electron spectrum of RdTh is the complex line at 2892 gauss cm, known as the M line. This line consists of the K conversion line of a 583-kev transition and the L conversion lines of a 511-kev transition, both ocurring in Pb^{208}. The means for effecting a resolution of the lines became available with the construction of the 100 cm $\pi\sqrt{2}$ air core magnetic electron spectrometer. A detailed plot of the line group is included. (N.W.R.)

15058 LINEARLY POLARIZED GAMMA RAYS FROM NUCLEAR REACTIONS. A. E. Litherland and H. E. Gove (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 39: 471-3(Mar. 1961). (AECL-1179)

A measurement made on gamma rays following β-decay and Coulomb excitation can be applied to gamma rays from nuclear reactions. The measurement is that of the degree of linear polarization. Measurements of the linear polarization and angular distributions of gamma rays from nuclear reactions can yield the parity change in the transition and can, when combined with other data such as angular distributions from capture reactions, yield in principle unambiguous information on dipole-quadrupole admixtures. (N.W.R.)

15059 STUDY OF THE β TRANSITION, FORBIDDEN IN THE FIRST ORDER ($3^- - 2^+$), OF EUROPIUM-152, BY MEANS OF THE CORRELATION BETWEEN THE ELECTRON AND THE POLARIZATION OF THE γ RAY ($2^+ - 0^+$). Jean Berthier, Roland Lombard, and Jules-Willy Sunier. Compt. rend., 252: 257-9(Jan. 9, 1961). (In French)

It is shown how the matrix elements are deduced from the correlation between the β ray and the polarization of the γ ray. The values of the matrix elements are adjusted in order to reproduce the experimental results. Several groups of values are possible. Those which agree best with the results obtained from the $\beta-\gamma$ angular correlation are chosen. The matrix element with the highest order is favored as in the analogous transition of Sb^{124}. (tr-auth)

15060 STUDY OF THE INELASTIC SCATTERING OF α PARTICLES AT 44 MEV BY CALCIUM-40. Jean Saudinos, René Beurtey, Philippe Catillon, Robert Chaminade, Monique Crut, Henriette Faraggi, André Papineau, and Jacques Thirion (Centre d'Etudes Nucleaires, Saclay, France). Compt. rend., 252: 260-2(Jan. 9, 1961). (In French)

The study of the inelastic scattering $Ca^{40}(\alpha,\alpha')$ shows that the levels excited in a preferential fashion have negative parity. (tr-auth)

15061 THE ANGULAR CORRELATION IN THE REACTION $Be^9(n,2n)Be^8$ WITH 14-Mev NEUTRONS. Hannes Jeremie. Compt. rend., 252: 403-4(Jan. 16, 1961). (In French)

In the reaction $Be^9(n,2n)Be^8$, the two neutrons leaving are emitted toward the front in a preferential fashion. (tr-auth)

15062 CROSS-SECTION FOR THE (n, 2n) REACTION ON C^{12}, N^{14}, O^{16}, AND F^{19} IN THE 10 TO 37 Mev ENERGY RANGE. O. D. Brill, N. A. Vlasov, S. P. Kalinin, and L. S. Sokolov. Doklady Akad. Nauk S.S.S.R., 136: 55-7(Jan. 1, 1961). (In Russian)

Cross sections of (n, 2n) reactions on light nuclei at 10 to 35 Mev were measured using neutrons from D(d, n)He^3 and T(d, n)He^4 reactions excited by 20 Mev deuterons. Solid ZnT and gaseous deuterium were used as targets. The activities of prepared specimens of carbon, ammonium nitrate and teflon (CF_2) irradiated by neutrons at 0° under standard conditions were measured with Geiger counters. The absolute magnitude of (n, 2n) reaction cross sections was determined for carbon at E_n = 34 Mev and for fluorine at E_n = 25 and 14 Mev. The 14-Mev neutrons were obtained in T(d, n)He^4 reactions. The results are plotted and the absolute values determined with an order of accuracy of ±30%. The neutron energy spread had a maximum of 0.7 Mev. In spite of the high level of error, the cross section curves plotted as functions of energy are considered reliable. A definite drop in cross sections following the C^{12}, N^{14}, and O^{16} maximums was observed. The small reaction cross sections in comparison to the total inelastic interaction cross sections is a peculiar characteristic of C^{12}, N^{14}, and O^{16}. The mechanism of the (n, 2n) reaction on light nuclei can be described as a combination of direct "knocking out" of a neutron and neutron pick-up similar to that in (n, d) reaction. (R.V.J.)

15063 EFFECT OF TEMPERATURE ON THE ANGULAR CORRELATION OF γ QUANTA ARISING ON THE ANNIHILATION OF POSITRONS AND ELECTRONS IN BISMUTH. I. Ya. Dekhtyar and V. S. Mikhalenkov (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Doklady Akad. Nauk S.S.S.R., 136: 63-5(Jan. 1, 1961). (In Russian)

The effects of high temperature on the angular correlations of γ quanta appearing in positron and electron annihilation and the variations of the anisotropic shape of the energy surface cross section are studied at 90°K. The data are correlated with data developed for 300°K. The correlation shows that for all oriented crystals the magnitudes of the angular distribution curve are considerably smaller at 90°K than at 300°K, and though the anisotropy of the magnitudes is retained at 90°K, the maximum anisotropy is ~8% while at 300°K it is 15%. (R.V.J.)

15064 ON THE THEORY OF MOSSBAUER'S EFFECT. I. P. Dzyub and A. F. Lubchenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Doklady Akad. Nauk S.S.S.R., 136: 66-9(Jan. 1, 1961). (In Russian)

The emission and absorption of γ quanta by nuclei in a crystal lattice were studied, and the variations in equilibrium positions and normal frequencies of lattice oscillations in relation to the state of the nucleus were evaluated.

The shapes of emission (or absorption) lines and the presence of non-displaced Mossbauer lines are analyzed. Using an adiabatic method, it is shown that the equilibrium of the solvent nucleus and the normal oscillation frequency of its lattice vary with the state of an admixture nucleus. (R.V.J.)

15065 MEASUREMENT OF THE FLUCTUATIONS IN IONIZATION PRODUCED BY α-PARTICLES IN ARGON. A. P. Kimar, A. A. Vorob'ev, and V. A. Korolev (Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 795-7(Feb. 1, 1961). (In Russian)

The ionization due to the α particles of Ra^{224} (E_α = 5.681 Mev) and Fr^{221} (E_α = 6.336 Mev) was measured on a grid ionization chamber filled with chemically pure argon (99.96%) and 1.5% CH_4 as a quenching gas. Special precautions were taken to reduce the noise background to a low value (175 e, where e is the electron charge). The half-width of Ra^{224} was found to be 17 kev (the mean square fluctuation of the number of ion pairs N for a fixed energy of the ionizing particles = δ = 7.2 kev). The formula $\delta_N (E\alpha) = 5.8 \sqrt{E_\alpha/6.0}$ is proposed for determining the mean square fluctuation δ_N in the number of ion pairs at various values of E_α. This formula agrees with the theory of Fano. (TTT)

15066 BETA-GAMMA ANGULAR CORRELATIONS OR THE CASCADES $3^-(\beta)\ 2^+(\gamma)\ 0^+$ OF Sb^{124} AND Eu^{152}. P. Debrunner, M. Lambert, A. Poncini, and J. W Sunier (Federal Inst. of Tech., Zurich). Helv. Phys. Acta, 33: 985-7(1960). (In French)

The directional correlations of the cascades 3^-(2.31 Mev β) 2^+(0.603 Mev γ) 0^+ of Sb^{124} and 3^-(1.48 Mev β) 2^+(0.344 Mev γ) 0^+ of Eu^{154} were measured as functions of β energies to determine the value of four matrix elements. From the coupling constants, $C_V = (1.41 \pm 0.01) \times 10^{-49}$ erg/cm^3 and $C_A = -1.25\ C_V$, the values were calculated and the results, normalized with respect to the nuclear radius R for the elements of "long" dimension, are tabulated. (J.S.R.)

15067 TOTAL NEUTRON CROSS SECTIONS FOR INTERMEDIATE NUCLEI AROUND 4 MEV. R. Ricamo (Università, Catania, Italy). Helv. Phys. Acta, 33: 997-8(1960). (In English)

The total neutron cross sections for P and S at neutron energies of 3, 4, and 5 Mev were measured by the transmission technique. The mean values obtained are diagramed. The total cross section of P at 4 and 5 Mev is higher than that of S as the absolute value of the binding energy of the last neutron in the compound nucleus is smaller for P. (J.S.R.)

15068 LIFETIME OF THE 161-KEV EXCITED STATE IN Sn^{117}. F. R. Metzger. J. Franklin Inst., 270: 138-42 (Aug. 1960).

Using the thermal resonance fluorescence method, the mean life of the 161-kev M1 transition in Sn^{117} is measured as $(5.7^{+3.3}_{-1.8}) \times 10^{-10}$ second. In arriving at this value, a total conversion coefficient β_T = 0.15 is assumed. (auth)

15069 ANGULAR DISTRIBUTION OF THE REACTION $B^{11}(p,\alpha_0)$ FROM 100 TO 300 Kev. R. Bouchez, H. Beaumevielle, J. Fleury, P. Perrin, R. de Swiniarski, and M. Chabre (Université et Centre d'Etude Nucléaires, Grenoble, France). J. phys. radium, 21: 819-21(Dec. 1960). (In French)

The angular distribution of the $B^{11}(p,\alpha_0)$ reaction was measured at energies of 148, 170, 200, and 255 kev and for the angles (CM) from 48° to 150° (10° interval). Beyond the 2^+ 163-kev resonance and up to 180 kev, the α_0 particles are more intense forward and backward at 148 kev, $I(\theta) \simeq 1 - 0.15 \cos\theta + 0.4 \cos^2\theta$; and at 163 kev, $I(\theta) \simeq 1 + 0.6 \cos^2\theta$. But this intensity decreases forward at 200 and 255 kev, prefiguring the 600-kev angular distribution for which the intensity is very low forward and backward. (auth)

15070 EXCITED LEVELS OF Sn^{116}. J. Colard, P. Gepts, L. Grenacs, A. Jones, and P. Lipnik (Université, Louvain, Belg.). J. phys. radium, 21: 863-9(Dec. 1960). (In French)

The energy levels of Sn^{116} were measured. The $\beta-\gamma$ coincidences confirmed the main features of the generally accepted scheme. Measurements of the slow $\gamma-\gamma$ coincidences have revealed the existence of the 1756-kev transition. The internal conversion method indicates J = 4 and positive parity for the 2535-kev level. On the other hand, the same measurements prove the absence of isomeric transition in In^{116} between the isomeric levels of 54 minutes and 13 seconds, having an intensity in excess of 0.5%. (auth)

15071 CROSS SECTION FOR THE REACTION $C^{12}(\gamma,3\alpha)$ AT 14.8 AND 17.6 Mev. M. Carnier, H. Gauvin, and W. Sebaoun (Institut du Radium, Orsay, France). J. phys. radium, 21: 893-5(Dec. 1960). (In French)

The number N_α of the reaction $C^{12}(\gamma,3\alpha)$ produced in a zone S of a nuclear emulsion containing ν_C atoms of C^{12} was determined and compared with the number N_{Cu} of the reaction $Cu^{63}(\gamma,n)$ produced in a thin Cu target, containing ν_{Cu} atoms of copper, superposed on the zone S. From the ratio of these two numbers the cross section for the $C^{12}(\gamma,3\alpha)$ reaction can be obtained. The methods used in the measurement of N_α and N_{Cu} are described. The reaction cross sections were calculated to be σ (14.8 Mev) = $(0.44 \pm 0.11) \times 10^{-28}$ cm^2 and σ (17.6 Mev) = $(1.90 \pm 0.21) \times 10^{-28}$ cm^2. (J.S.R.)

15072 THE ENERGY OF NEUTRONS FROM REACTION $Be^9/\alpha,n/C^{12}$. L. Medveczky (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Magyar Tudományos Akad. Atommag Kutató Intezéte (Debrecen). Közlemények, 2: No. 3, Suppl., 6p.(1960). (In English)

The investigated nuclear reaction was produced by a Po^{210} alpha source. The energy of the neutron was measured by the photoemulsion method in directions of 30, 90, 120, 150, and 180°. In some of the cases, the Q value, i.e., the relative intensity of neutron groups, can be determined from the distribution of neutrons. (auth)

15073 INVESTIGATIONS ON THE DECAY SCHEME OF I^{131} IN THE LOW ENERGY REGIONS OF GAMMA-RAYS. D. Berényi, Gy. Máthé, and T. Scharbert (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Magyar Tudományos Akad. Atommag Kutató Intezête (Debrecen). Közlemények, 2: No. 3, Suppl., 5p.(1960). (In English)

The region below 364 kev energy of gamma radiation from the decay of I^{131} was examined by scintillation techniques with ordinary as well as with the sum-coincidence method. A new cascade of 156 to 210 kev (of an intensity of ~1% in relation to the cross-over transition) from a level of 364 kev into the ground state was found. Furthermore, the existence of the 177 kev line was confirmed. (auth)

15074 EMISSION OF SOFT ELECTROMAGNETIC RADIATION FROM METALS BY THE IMPACT OF HIGH-ENERGY PROTONS AND POSITIVE IONS. Rafi Mohammed Chaudhri and Mustaf Yar Khan (High Tension and Nuclear Research Lab., Lahore, West Pakistan). Nature, 189: 996-7(Mar. 25, 1961).

Ultraviolet and visible radiations were emitted from a nickel surface bombarded with 400 to 700 kev protons and positive ions. The intensity of the radiation in the ultra-

violet region above 3300 A was greater than that of the visible part of the spectrum. The spectrum in the visible region was continuous, with a pronounced flat peak between 4600 and 4900 A. A spot visible to the naked eye appeared on the target with as small a current as 10^{-7} amp. The experimental technique is described. (C.H.)

15075 DELAYED NEUTRONS IN NUCLEAR FISSION. Klaus-Werner Hoffmann (Universität, Göttingen, Ger.). Naturwissenschaften, 48: 36-9(1961). (In German)

The origin, half life, yield, correlation, and energy spectrum of delayed neutrons from nuclear fission are reviewed. (J.S.R.)

15076 THE RESONANCE FISSION INTEGRALS OF U^{235}, Pu^{239}, AND Pu^{241}. J. Hardy, Jr., D. Klein, and G. G. Smith (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 9: 341-5(Mar. 1961).

The resonance fission integrals of U^{235}, Pu^{239}, and Pu^{241} were measured relative to the gold resonance capture integral by the cadmium ratio method. The cadmium ratios were measured in a reactor at a position where the epicadmium flux spectrum was closely 1/E except for a peak above 25 kev. A small spectrum correction was made for this flux peak to infer the fission integral over a pure 1/E spectrum using a calculated epicadmium flux spectrum. The resonance integrals obtained were, with a 0.5-ev cutoff energy, 274 ± 11b, 327 ± 22b, and 557 ± 33b for U^{235}, Pu^{239}, and Pu^{241}, respectively. (auth)

15077 MINIMUM CRITICAL DIMENSIONS FOR WATER SOLUTIONS. C. B. Mills (Los Alamos Scientific Lab., N. Mex.). Nuclear Sci. and Eng., 9: 377-90(Mar. 1961).

By use of the Los Alamos transport code, a parametric set of criticality conditions for one-dimensional geometries of light water solutions of the fissionable materials U^{233}, U^{235}, and Pu^{239} was determined. Minimum critical dimensions for slabs and cylinders and critical radius, mass, and volume for spheres as a function of solution concentrations (kg/l) and H/X atomic ratio are shown for bare and light water reflected solutions. Results of experimental studies for critical dimensions are given to support the study. (auth)

15078 THE ABSOLUTE MEASUREMENT OF THE DECAY RATE BY MEANS OF THE β-γ COINCIDENCE METHOD AND ITS APPLICATION TO THE MEASUREMENT OF THE THERMAL ACTIVATION CROSS SECTION OF THE ISOTOPES Na^{23}, Sc^{45}, Co^{59}, AND Ta^{181}. Gerd Wolf (Technische Hochschule, Munich). Nukleonik, 2: 255-71(Dec. 1960). (In German)

For a number of isotopes used for thermal neutron flux measurements, a new determination of the activation cross section was made. The necessary absolute determination of the decay rate was made by the β-γ coincidence method and the 4π β-γ coincidence method. Both methods are completely discussed with respect to the physical hypotheses and the apparatus used. An equation for the statistical errors in the 4π β-γ method is given. The substances were irradiated in the FRM Reactor for activation. Inhomogeneities and temporal oscillations of the neutron field were determined by arranging the substances on a turntable. Gold (σ_a = 98.7 b) was used as reference. In order to eliminate the effect of epithermal neutrons, cadmium ratios were measured. Data on resonance integrals were obtained. The half life of Na^{24} was measured as 14.953 ± 0.013 hr. The following activation cross sections were obtained: Na^{23} – 0.531 ± 0.008, Co^{59} – 38.0 ± 0.5, Sc^{45} – 28.3 ± 0.7, and Ta^{181} – 21.0 ± 0.7 barns. Up to the value of Sc^{45} the results agree well with previously obtained values. (tr-auth)

15079 NUCLEUS-NUCLEUS REACTION CROSS SECTION AT HIGH ENERGY COLLISIONS. G. Alexander and G. Yekutieli (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo cimento (10), 19: 103-17(Jan. 1, 1961). (In English)

The nucleon-nucleus and nucleus-nucleus reaction cross sections at high energies for various elements are calculated according to the optical model as a function of σ_0, the effective nucleon-nucleon total cross section in nuclear matter. Use is made of the charge distributions of various nuclei recently obtained from electron scattering experiments. The results are compared with existing data of experiments using machine beams and cosmic ray particles. Except for the very light nuclei, a general agreement is found for values of σ_0 differing only by a few percent from the free nucleon-nucleon total cross section. (auth)

15080 THE PHOTOFISSION OF Bi, Th AND U BETWEEN 300 AND 1000 MeV. H. G. de Carvalho (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples), A. Celano, G. Cortini, R. Rinzivillo, and G. Ghigo. Nuovo cimento (10), 19: 187-9(Jan. 1, 1961). (In English)

Photofission cross sections for Bi^{209}, Th^{232}, and U^{238} are studied for photon energies from 300 to 1000 Mev. Emulsions are exposed to a collimated gamma beam, and the stars which are produced are studied. A discussion of the theory of star production in terms of meson emission and reabsorption is given. The photofission and star production cross sections for the three nuclei under consideration are measured, and the fissionability of the nuclei is calculated. It is suggested that the star production cross sections are enhanced by coherent production of π^0 mesons and $\pi^+\pi^-$ pairs. It is observed that, while the fissionability is dependent on the nucleus considered, it is independent of the excitation energy of that nucleus. (T.F.H.)

15081 PREDICTIONS OF SPONTANEOUS FISSION HALF-LIVES FOR HEAVY NUCLEI. David W. Dorn (Univ. of California, Livermore). Phys. Rev. 121: 1740(Mar. 15, 1961). (UCRL-6165)

Swiatecki's work on correlation of spontaneous fission half lives was modified and extended to include elements beyond Z = 100. The values predicted on these bases are unexpectedly high. For example, the partial half life for Z = 106, A = 271 is predicted to be about 13 years. (auth)

15082 ENERGY LEVELS IN Zr^{91} EXCITED BY THE (d,p) REACTION. R. L. Preston, H. J. Martin, Jr., and M. B. Sampson (Indiana Univ., Bloomington). Phys. Rev., 121: 1741-4(Mar. 15, 1961).

Eleven energy levels in Zr^{91} were excited. The excitation energies of the levels are 0, 1.22, 2.07, 2.19, 2.56, 2.84, 3.05, 3.25, 3.45, 3.65, and 3.87 Mev. Angular distributions were measured for the first four levels and assignments were made using the shell-model and the Butler stripping theory. The assignments are $2d_{5/2}$ for the ground state, $3s_{1/2}$ for the 1.22-Mev state, $2d_{3/2}$ for the 2.07 Mev-state, and $1g_{7/2}$ for the 2.19-Mev state. The application of the Butler theory to the data gave reasonable and useful fits. The ground-state Q value was measured and is 5.02 ± 0.03 Mev. (auth)

15083 NATURAL ALPHA RADIOACTIVITY IN MEDIUM-HEAVY ELEMENTS. Ronald D. Macfarlane and Truman P. Kohman (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 121: 1758-69(Mar. 15, 1961).

A large cylindrical ionization counter accommodating samples up to 1200 cm^2 in area was used for measurements of natural alpha radioactivity in medium-heavy elements. Low-background techniques and multichannel pulse analysis are employed. The method has greater energy resolution and yields better counting statistics than the nuclear emul-

sion technique, but does not have as great a sensitivity. The results obtained from measurements on natural elements and isotopically enriched samples are given for Ce^{142}, Nd^{144}, Sm^{146}, Sm^{147}, Sm^{148}, Sm^{149}, Gd^{152}, Hf^{174}, W^{180}, Pt^{190}, and Hg^{196}. (auth)

15084 O^{14} DECAY ENERGY AND THE FERMI INTERACTION CONSTANT. J. W. Butler and R. O. Bondelid (U. S. Naval Research Lab., Washington, D. C.). Phys. Rev., 121: 1770-3(Mar. 15, 1061).

The threshold energy of the $C^{12}(He^3,n)O^{14}$ reaction was measured precisely with the use of a Van de Graaff accelerator and an electrostatic analyzer, the value being 1436.2 ± 0.9 kev. From this value, the O^{14} beta decay end-point energy (for decay leading to the 2312-Mev state in N^{14}) is computed to be 1.8000 ± 0.0065 Mev, based on the 1956 table of mases, and 1.8097 ± 0.0015 Mev, based on the 1960 table of masses. A revised value of the Fermi interaction constant in beta decay is calculated and applied in the conserved vector current theory of Feynman and Gell-Mann. When the radiative corrections and other corrections are applied to the decay of O^{14}, the corrected ft value is used to compute the vector coupling constant in beta decay, the value of this vector coupling constant is assumed to be the same as that for the muon decay and is used to calculate the lifetime of the muon, and this lifetime is corrected for radiation effects, the predicted mean life of the muon becomes 2.289 ± 0.013 μsec (based on the 1960 table of masses and the radiative corrections of Kinoshita and Sirlin) or 2.245 ± 0.013 μsec (based on the 1960 table of masses and the corrections, radiative and otherwise of Durand and collaborators). The former value is 3.6% greater than a weighted average of several recent measurements of the muon mean life, 2.210 ± 0.003 μsec, while the latter value is only 1.6% greater, and is within the combined experimental and theoretical uncertainties. However, the definitions of coupling constants used by Durand and collaborators differ somewhat from those used by others. (auth)

15085 ANALYSIS OF LONG-RANGE ALPHA-EMISSION DATA. R. D. Griffioen and J. O. Rasmussen (Univ. of California, Berkeley). Phys. Rev., 121: 1774-8(Mar. 15, 1961).

Alpha barrier penetrabilities for the long-range alpha particles of Po^{212} and Po^{214} are calculated by using the diffuse exponential nuclear potential derived from optical-model analysis of alpha-particle elastic-scattering data. The calculations are made on the same basis as reported by Rasmussen in two previous publications. Partial half lifes for alpha and gamma emission are calculated on the assumption that the long-range alpha decay is unhindered with respect to the ground-state alpha decay. (auth)

15086 METHOD TO OBTAIN THE ENERGY DEPENDENCE OF REACTION CROSS SECTIONS WHEN A COMPOUND NUCLEUS IS FORMED. Raymond Fox and Richard D. Albert (Univ. of California, Livermore). Phys. Rev., 121: 1779-81(Mar. 15, 1961). (UCRL-5905)

It is found that measuring the energy distribution of emitted particles at two different incident energies and two reaction cross sections is sufficient to obtain the energy dependence of a reaction cross section when it is known that a compound nucleus is formed. The cross sections obtained are a function of the excitation energy of the residual nucleus. They are the usual reaction cross sections at zero excitation energy when the assumption is made that the reaction cross section does not vary with the excitation energy of the target nucleus. By comparing the reaction cross sections thus obtained with measured nonelastic cross sections, the compound elastic cross section may also be obtained. An example using this method is given in which two measured energy distributions and two measured cross sections were used to obtain the energy dependence of the reaction cross section of nickel in the 2.5- to 7-Mev energy range. (auth)

15087 DECAY OF Ne^{18}. J. W. Butler and K. L. Dunning (U. S. Naval Research Lab., Washington, D. C.). Phys. Rev., 121: 1782-7(Mar. 15, 1961).

The radioactive nuclide Ne^{18} was produced in the $O^{16}(He^3,n)Ne^{18}$ reaction by 5.2-Mev He^3 particles from the NRL 5-Mv Van de Graaff accelerator. The target, CaO on a Pt backing, was about 300 kev thick to the incident beam. The gamma rays following the decay of Ne^{18} were detected by a 3-in. diam by 3-in. NaI(Tl) crystal and a 256-channel pulse-height analyzer. Only one nuclear gamma ray was observed. Its energy, measured with respect to the Na^{22} gamma ray at 1.2736 ± 0.0016 Mev, is 1.041 ± 0.005 Mev. Therefore, this gamma ray is assigned to the 1.04-Mev state of F^{18}. This state is considered to be the isobaric spin analog state of the Ne^{18} ground state, and therefore has quantum parameters 0^+, T = 1. The branching to this excited state was measured to be 0.07 ± 0.02 (including a calculated contribution of 0.00006 from orbital electron capture), and that to the ground state of F^{18} was measured to be 0.93 ± 0.02 (including a calculated contribution of 0.0002 from orbital electron capture). The ft values are, respectively, 3030 ± 880 and 1120 ± 70 sec. The half life of Ne^{18} was measured to be 1.46 ± 0.07 sec. (auth)

15088 EXCITATION FUNCTIONS OF (p,2 NUCLEON) REACTIONS. P. P. Strohal and A. A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 121: 1815-22 (Mar. 15, 1961).

Excitation functions for the (p,pn) reaction were determined in the energy range 250 to 440 Mev for the target nuclei As^{75}, Br^{81}, Zr^{96}, I^{127}, Ce^{142}, W^{186}, and Re^{187}. Both isomer products were determined in the case of the $Br^{81}(p,pn)Br^{80}$ reaction. Also, excitation functions were determined for the (p,2p) reaction on Zr^{96}, Ce^{142}, and W^{186} and for the (p,2n) reaction on Zr^{96}. All cross sections were measured relative to the $Al^{27}(p,3pn)Na^{24}$ excitation function. The (p,pn) excitation functions are only moderately sensitive to energy showing an increase by about 30% for iodine, 20% for arsenic and cerium, and a 12% decrease for zirconium. The remaining excitation functions are flat. The ratio of $\sigma_{p,pn}$ to $\sigma_{p,2p}$ is 1.62 ± 0.09, for the three targets measured, at 440 Mev. The various mechanisms for the production of reactions of this type are examined in the light of present understanding. The suggestion is made that, despite the relative insensitiveness of these excitation functions to energy, (p,pn) and (p,2p) reactions may take place by more than one mechanism in this energy region. A comparison is made with the results of recent Monte Carlo nuclear cascade calculations applied to calculation of (p,pn) reaction excitation functions. (auth)

15089 TRANSFORMATION BRACKETS FOR HARMONIC-OSCILLATOR STATES. B. J. Verhaar (Universiteit, Amsterdam). Physica, 26: 1047-56(Dec. 1960). (In English)

Calculations for the nuclear harmonic-oscillator shell model were simplified by the introduction, by Moshinsky, Balashov, and Eltekov, of so-called transformation brackets. These brackets are defined as the coefficients in the transformation connecting two-particle states to center-of-mass states for a system. This paper relates the notation used by Moshinsky, Balashov, and Eltekov to more well-known coefficients, such as $\frac{1}{2}\lambda$ (pseudo-spin) and $d^{(j)}_{m'm}$, as tabled by Edmonds. (T.F.H.)

15090 ON THE (d,α) REACTIONS. M. El-Nadi (Cairo Univ.) and M. Wafik. Proc. Math. and Phys. Soc. U.A.R., No. 23: 117-23(June 1959). (In English)

The differential cross section for the (d,α) reaction is given together with the effect of the nuclear radius and the form of the wave function of the α particle on the shape of the angular distribution. (auth)

15091 SELF-ABSORPTION CORRECTION FOR ISOTOPES EMITTING WEAK BETA RAYS. P. Massini (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Science, 133: 877-8(Mar. 24, 1961).

The shape of the self-absorption correction curve of β emitters is not universal but depends on the geometrical arrangement of the sample and counting device. This may explain why the correction factor defined by Hendler is not always linearly related to the thickness of the sample. (auth)

15092 THE FISSION OF HEAVY AND LIGHT NUCLEI OF AN EMULSION BY PROTONS WITH AN ENERGY OF 660 Mev. G. Tleubergenova and V. Botvin. Vestnik Akad. Nauk Kazakh S.S.R., No. 8, 32-43(1960).

The fission of light and heavy nuclei in emulsions by 660 Mev protons is studied. A collimated 660 Mev synchrocyclotron beam with a flux of 10^6 particles/cm^{2}sec is used. 246 interactions are chosen and classified, using a potential-barrier model, as light- or heavy-nucleus reactions. Studies are made of fission cross sections, mean free paths, angular distributions and energy spectra of charged decay products, average numbers of decay products per fission, etc. The results for both light and heavy nuclei are found to agree with optical model predictions. (TCO)

15093 THE KINETIC ENERGY OF FISSION FRAGMENTS. W. Brunner and H. Paul (Kernphysikalisches Institut Der Deutschen Akademie der Wissenschaften, Berlin). Z. Naturforsch, 15a: 1109-10(Dec. 1960). (In German)

In a previous paper (Z. Naturforsch. 15a, 1018(1960)) a study was made to clarify the experimentally known mass distribution in the fission of U^{235} with thermal neutrons on the basis of the introduction of a shell structure dependent deformation of the fragments at the moment of their origin. In the present study it is shown that, from the same physical representation, the trend of the mean kinetic energy of the fragments and of the magic effect in the magnitude of the fission fragment deformation can be understood. (J.S.R.)

15094 ISOTOPIC SHIFT BETWEEN THE STRONTIUM ISOTOPES 84, 86, 88, AND 90 AND THE FLOW IN THE NUCLEAR VOLUME EFFECT NEAR NEUTRON NUMBER 50. K. Heilig (Universität, Heidelberg). Z. Physik, 161: 252-66(1961). (In German)

The isotopic shift in the strontium isotopes 84, 86, 88, and 90 (neutron numbers 46, 48, 50, and 52) was investigated with a recording photoelectric Fabry-Perot spectrometer. Hollow cathodes covered with only 1 mg of material to be studied were used as light sources, which permitted the intensive excitation of the resonance lines of the I and II spectra for 4 hr. The isotopic shift of the stable isotopes 84, 86, and 88 has the sign of the nuclear mass effect. The shift between the isotope 88 and radioisotope 90, on the other hand, has the sign of the nuclear volume effect. The isotopic positions in the strontium II resonance lines are (84) -12.4 ± 0.5, (86) -5.8 ± 0.3, (88) 0, and (90) -11.4 ± 1.2 ($\times 10^{-3}$ cm^{-1}). A corresponding isotope position was found in the strontium I resonance lines. It was established that in the introduction of two neutrons outside the closed shell N = 50 the nuclear volume effect of the isotopic shift jumps from small to large values. The jump occurring at N = 50 in the nuclear volume effect is of the same magnitude as the well-known jump at N = 82. (tr-auth)

15095 HYPERFINE STRUCTURE SPLITTING OF RECOILLESS γ LINES. I. THE 80.6-Kev LEVEL IN Er^{166}. R. L. Mössbauer, F. W. Stanek, and W. H. Weidemann (Technische Hochschule, Munich). Z. Physik, 161: 388-91 (1961). (In German)

By the method of recoilless γ emission and absorption, the weakening of the 80.6-kev γ line of Er^{166}, which was embedded in Ho_2O_3, was measured in an Er_2O_3 absorber as a function of the velocity of the absorber. The temperature of source and absorber was 20°K. A complicated splitting pattern was obtained for components whose line broadening corresponded approximately to the life time of the excited state. The line at about 1600 Mc was split in two for source and absorber. (tr-auth)

15096 INVESTIGATIONS ON THE NON-RESONATING PART OF THE $Li^7(p,\gamma)$ RADIATION. G. Breuer, V. Riech, E. Thormann, and H. Neuert (Institut für Experimentalphysik, Hamburg). Z. Physik, 161: 500-8(1961). (In German)

The angular distributions of the 17.6-Mev γ rays from the reaction $Li^7(p,\gamma)Be^8$ were measured between $E_p = 0.4$ Mev and $E_p = 0.65$ Mev. The known strong asymmetry resulting from interference of the 441-kev resonance radiation and the nonresonant radiation and a $\cos^2\Theta$-term, slowly increasing with energy, were observed. According to the results the nonresonant radiation is predominantly due to s-wave capture, but in addition to this a small contribution of p-waves must be considered. (auth)

15097 ELASTIC AND INELASTIC SCATTERING OF DEUTERONS ON C, Mg, Ti, Fe, Ni, Cu, AND Zn AT 11.8 Mev. R. Jahr, K. D. Müller, W. Oswald, and U. Schmidt-Rohr (Max-Planck-Institut für Kernphysik, Heidelberg, Ger.). Z. Physik, 161: 509-24(1961). (In German)

The spectra of deuterons scattered from C, Mg, Ti, Fe, Ni, Cu, and Zn were measured in steps of 5° between $\Theta_{lab} = 20°$ and 165°. The excitation of the lowest levels is in most nuclei strongly preferred and only very few low-energy deuterons were observed. The angular distributions of the elastic and inelastic scattering of deuterons show pronounced diffraction maxima which are partly correlated. The correlation is compared with the Blair model. (auth)

15098 DECAY SCHEMES OF RADIOACTIVE NUCLEI. (In English Translation). B. S. Dzhelepov and L. K. Peker. Translation ed., D. L. Allan. New York, Pergamon Press, 1961. 709p. $20.00.

A systematic presentation is given of available information on radioactive decay schemes. Diagrams are constructed using experimental data published through 1957. Data on spins and magnetic dipole and electric quadrupole moments of stable nuclei are also presented. [A previous translation (AECL-457) of an earlier version of this publication was abstracted in NSA Vol. 12, abstract number 3854.] (T.F.H.)

Particle Accelerators

15099 (MURA-595) COMPUTATIONAL STUDIES OF COUPLING RESONANCES IN SPIRALLY-RIDGED ACCELERATORS. C. A. Lassettre (Midwestern Universities Research Assn., Madison, Wis.). Jan. 2, 1961. Contract AT(11-1)-384. 26p.

Computational results for the $\sigma_x = 2\sigma_y$, $\sigma_x + 2\sigma_y = 2\pi$, $2\sigma_x + 2\sigma_y = 2\pi$, and $3\sigma_x + 2\sigma_y = 2\pi$ resonances are presented for

large scaling, FFAG spirally-ridged accelerators. For the two lower order resonances, the results agree well with the theoretical predictions of Sessler and Laslett. For the two higher order resonances, agreement is good only when very close to the resonance line. The anticipated improvement of agreement over the computational results involving small accelerators was not as much as anticipated. (auth)

15100 (CEA-tr-R-1094) ETUDE DE L'ENTRAINEMENT DES ÉLECTRONS DANS LES ACCÉLÉRATEURS DU TYPE BÉTATRON ET SYNCHROTRON. (Study of the Entrainment of Electrons in Accelerators of the Betatron and Synchrotron Type). Translated into French by B. Vinogradoff from Atomnaya Energ., 6: No. 1, 68-9 (1959). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 18196.

15101 THE STOCHASTIC METHOD FOR ACCELERATING PARTICLES. E. L. Burshtein, V. I. Veksler, and A. A. Kolomenskii. p.3-6 of "Nekotorye Voprosy Teorii Tsiklicheskikh Uskoritelei," Moscow, 1955.

The stochastic method of particle acceleration is briefly reviewed. It is assumed that the charged particle passes consecutively through a series of accelerating gaps, to which an electric voltage variable in time is applied; at the same time the phase of the accelerating voltage at the moment of the particle passage is a random value. In the calculations it is assumed, for simplicity's sake, that the accelerating voltage takes only two values $+V_0$ and $-V_0$. Under these conditions the probability W of the acceleration of the particle to an energy of $E_k = keV_0$ is determined, where k is an integer. The value of W proves to be $W_k = eV_0/2Ek$. The possibility of a stochastic process of acceleration in cyclic accelerators is pointed out. (TCO)

15102 FIXED FREQUENCY CYCLOTRON OPERATION WITH A REGULATOR FOR DEE VOLTAGE STABILIZATION. H. Fauska, J. W. Orth, and F. H. Schmidt (Univ. of Washington, Seattle). Nuclear Instr. & Methods, 10: 73-83 (Feb. 1961). (In English)

A severe time modulation of the beam from a 152 cm cyclotron is found to be caused by dee voltage fluctuations. To eliminate this difficulty, a series-type regulator is constructed. The regulator controls the oscillator plate power voltage in order to maintain a constant and ripple-free potential on one dee. Under average conditions of use the dee voltage is constant to ±0.15%. In addition to improving the beam time stability, the regulator introduces several unexpected features of cyclotron performance. The deflected beam goes through pronounced peaks and valleys as the dee voltage is varied. The deflection efficiency is greater when the dee voltage is set on a beam maximum. Stability of the cyclotron against sparking is improved. The focussed beam image in a scattering chamber remote from the cyclotron is substantially smaller showing that the beam energy spread is less. (auth)

15103 A MAGNETIC PARTICLE SPECTROMETER FOR USE WITH A 12 Mev TANDEM ELECTROSTATIC GENERATOR. A. V. Cohen, J. A. Cookson, and J. L. Wankling (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Instr. & Methods, 10: 84-94(Feb. 1961). (In English)

A double-focussing magnetic particle spectrometer, with a solid angle of acceptance of 0.007 steradians is described. The resolving power in energy is 850 for protons of up to 12 Mev; saturation effects lower this figure to 450 for protons of 21 Mev. Use of the spectrometer, both for measuring the yields of nuclear reactions, and as a tool for investigating the gamma decay modes of selected nuclear levels, is discussed. (auth)

15104 DEFLECTION COIL FOR AN EXTERNAL ACCELERATOR BEAM. R. Benaroya and W. J. Ramler (Argonne National Lab., Ill.). Nuclear Instr. & Methods, 10: 113-20(Feb. 1961). (In English)

A compound vertical and horizontal deflection coil using a motor-stator type iron core and a winding with a sinusoidal turns distribution makes a useful tool for precisely positioning and sweeping the external beam of an accelerator. The design, method of construction, performance and characteristics of this coil are discussed. (auth)

15105 A COLD CATHODE ION SOURCE FOR A SYNCHROCYCLOTRON. Ake Svanheden (Univ. of Uppsala). Nuclear Instr. & Methods, 10: 125-8(Feb. 1961). (In English)

Ion sources of the cold cathode type are installed in the Uppsala synchrocyclotron. Two ion sources with uranium cathodes are placed symmetrically above and below the median plane of the pole gap, and both can be operated simultaneously. The arc working voltage is in the region of 700 volts with a hydrogen gas working pressure of around 5 mTorr (5×10^{-3} mm Hg). The beam intensity is slightly increased with this new type of ion source, and the working stability is very good. (auth)

15106 ENERGY DISTRIBUTION AND ENERGY STABILITY OF THE ELECTRON BEAM FROM A 5 Mev BETATRON. Torbjorn Westermark (Royal Inst. of Tech., Stockholm). Nuclear Instr. & Methods, 10: 145-63(Feb. 1961). (In English)

The adaptation of the Wernholm-Smårs 5 Mev betatron for precise operation is described. Assembly, improvements and normal operation are described as well as a method for recording, by an XY-recorder, the spectrum of the electron line as detected with a magnetic spectrometer and current scanning. The stability of the electron energy is better than ±1 Kev for 3 hours' operation after introduction of a peaking-strip transformer due to Smårs. The half-width of the electron line was studied as a function of a number of parameters. It is suggested that ejection should be made at large phase angles if the ejection time is finite. The best half-width obtained is 2.6% at 2.8 Mev; it is shown to be due partly to the windows used and partly to the spectrometer slits and aberrations. A certain part, about 1 kev, is due to the betatron itself — perhaps caused by the finite ejection time period and betatron oscillations. (auth)

15107 BREMSSTRAHLUNG SPECTRUM OF THE 1000 MeV ELECTRONSYNCHROTRON AT FRASCATI. G. Diambrini (Comitato Nazionale per le Ricerche Nucleari, Frascati, Italy). A. S. Figuera, B. Rispoli, and A. Serra. Nuovo cimento (10), 19: 250-64(Jan. 16, 1961). (In English)

The final results of some measurements on angular distribution and on Bremsstrahlung spectrum of the γ-ray beam of the Frascati electronsynchrotron are given. The experimental results of angular distribution for thick target fit with Schiff's theoretical angular distribution. A difference between theory and experiments is found for thin targets and this can be explained by multiple crosses through the target of the accelerated electrons. For the spectrum shape for thin targets the experimental points are in fair agreement with the theoretical provisions, while for thick targets a difference is found in the high energy range and this difference can be explained by many different causes. (auth)

5108 EXPERIMENTAL INVESTIGATION OF A NEUTRAL BEAM FROM THE CERN 25 GeV PROTON SYNCHROTRON. M. Fidecaro, G. Gatti, G. Giacomelli, W. A. Love, J. C. Middelkoop, and T. Yamagata (European Council for Nuclear Research, Geneva). Nuovo cimento (10), 19: 382-92(Jan. 16, 1961). (In English)

The spectra of photons from the CERN 25 Bev proton synchrotron using aluminum and beryllium internal targets were measured at the laboratory angles of 3.2 and 15.9° by means of a lead glass total absorption Cherenkov counter. While at 3.2° the intensity is slightly higher than that predicted by the statistical model with the assumption of isotropy in the c.m. system, at 15.9° it is about an order of magnitude below this prediction. This is interpreted as an indication of anisotropy in c.m. system. The 3.2° beam, at 4 m from the target, has an intensity of about 13,600 photons above 1 Bev per cm^2 when 10^{11} protons impinge on a beryllium target. The number of neutrons is found to be about a factor of 2 below the number of γ-rays of energy larger than 2 Bev. Attenuation measurements of γ-rays and neutrons are performed in carbon, CH_2, and lead. (auth)

5109 LINEAR ACCELERATOR RESONATOR AS A MICROWAVE OSCILLATOR LOAD. A. P. Fedotov and B. K. Shembel. Radiotekh. i Elektron., 6: 108-16(1961). (In Russian)

A scheme equivalent to a linear accelerator resonator with a strong beam load, considering load as a function of field amplitude and phase, is analyzed. The equivalent system contributes to an evaluation of the linear resonator incoming resistance. Data on the performance of the accelerator model under strong beam load are included. (tr-auth)

5110 OPTIMAL FOCUSING OF ELECTRON BEAM IN A T. W. T. PERIODICAL FOCUSING SYSTEM. A. L. Agritskii. Radiotekh. i Elektron., 6: 137-45(1961). (In Russian)

A new analytical method is suggested for determining parameters for a periodic focusing device (mechanism of spatial interaction of electrons with plasma LBV) for electron beams. It is shown that the suggested method is capable of achieving considerably smaller electron beam undulation than has been achieved by the commonly used Chang method. The method permits the development of an accurate electron beam configuration, depending on the conditions under which the electron is injected into the periodic field. It is shown that much better focusing can be achieved with maximum electron induction into the field. (tr-auth)

5111 RESONANT BEAM EXTRACTION FROM AN A.G. SYNCHROTRON. C. L. Hammer and L. Jackson Laslett (Iowa State Univ., Ames and Midwestern Universities Research Assn., Madison, Wis.). Rev. Sci. Instr., 32: 44-9(Feb. 1961).

The resonant extraction method previously proposed for the normally constant gradient synchrotron was extended to alternate gradient accelerators. It was found the perturbation field gradients which contain circular functions of arguments ($2\nu_x$, $2\nu_x + 1$, and $2\nu_x + 2$) are particularly effective in causing the radial betatron oscillations to grow exponentially at a particular azimuthal position. The analytical procedure for predicting which perturbations give optimum results and digital computer calculations verifying these predictions are presented. (auth)

5112 CALCULATIONS OF PROPERTIES OF MAGNETIC DEFLECTION SYSTEMS. S. Penner (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr., 32: 150-60(Feb. 1961).

A convenient matrix method for calculating properties of magnetic deflection systems is presented. This method is applicable to particle beams of small spatial and angular extent and small energy spread. Equations for quadrupole lenses and for deflecting magnets are given. Examples are given to show the procedure for calculating the parameters of magnet systems. (auth)

15113 GAS LEAK VALVE WITH IMPROVED CHARACTERISTICS. J. W. Johnson and W. M. Good (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 32: 219-20(Feb. 1961).

A mechanical variable gas leak valve with improved operating characteristics was used for feeding helium to the ion source of a Van de Graaff accelerator. The leak consisted of two commercially available sensitive needle valves joined in series by a small volume. (M.C.G.)

15114 COHERENT ELECTROMAGNETIC EFFECTS IN HIGH CURRENT PARTICLE ACCELERATORS. I. INTERACTION OF A PARTICLE BEAM WITH AN EXTERNALLY DRIVEN RADIO-FREQUENCY CAVITY. V. Kelvin Neil and Andrew M. Sessler (Univ. of California, Berkeley). Rev. Sci. Instr., 32: 256-66 (Mar. 1961). (UCRL-9326)

A calculation is made of the interaction of a beam of particles in an accelerator with the radio-frequency cavity that provides the accelerating mechanism of the machine. A Hamiltonian for synchrotron motion is employed that makes possible the simultaneous solution of Maxwell's equations and the Vlasov equation, so that a self-consistent distribution of particles in synchrotron phase space is determined. The effective voltage on the cavity due to the beam of charged particles is of the order of magnitude of the product of the total circulating current in the accelerator and the shunt impedance of the r-f cavity. It has the net effect of producing a total voltage on the cavity which is both less than the applied voltage, and shifted in phase with respect to it. The increase in the stable phase angle required so the particles will remain in phase with the accelerating radio frequency is calculated. The decrease in total voltage and increase in stable phase angle result in a decrease in stable phase space available for acceleration, and convenient expressions are given for these quantities in terms of parameters of the accelerator. It is shown that the consequences of the induced voltage may be alleviated by increasing the voltage applied to the cavity. Nonresonant interaction between the beam and cavity is not considered. (auth)

15115 COHERENT ELECTROMAGNETIC EFFECTS IN HIGH CURRENT PARTICLE ACCELERATORS. II. ELECTROMAGNETIC FIELDS AND RESISTIVE LOSSES. V. Kelvin Neil (Univ. of California, Berkeley), David L. Judd, and L. Jackson Laslett. Rev. Sci. Instr., 32: 267-76 (Mar. 15, 1961). (UCRL-9327)

Coherent electromagnetic fields arising from an azimuthally modulated beam are considered. The beam is completely enclosed in a toroidal vacuum tank of rectangular cross section and highly conducting walls. Expressions are given for the image currents arising from low harmonics of the beam circulation frequency. These expressions are then used to evaluate resistive losses in the walls of the chamber. Expressions are given for fields arising from low harmonics of the revolution frequency high enough that the beam may be in resonance with a characteristic mode of the vacuum chamber. The results are generalized to provide a description of the electric field in the neighborhood of a resonance. Numerical examples of resistive losses are given, indicating that these effects will not be serious for circulating currents of the order of 1 amp. Some properties of high-order Bessel functions, required for a de-

scription of the resonant chamber modes and the energy lost in their excitation, are developed in an appendix. (auth)

15116 COHERENT ELECTROMAGNETIC EFFECTS IN HIGH CURRENT PARTICLE ACCELERATORS. III. ELECTROMAGNETIC COUPLING INSTABILITIES IN A COASTING BEAM. L. Jackson Laslett (Ames Lab., Ames, Iowa and Midwestern Universities Research Assn., Madison, Wis.). Rev. Sci. Instr., 32: 276-9(Mar. 1961). (UCRL-9328)

The electromagnetic interaction of an intense relativistic coasting beam with itself, including the effect of a nonperfectly conducing vacuum tank, or a quiescent r-f cavity, is investigated theoretically. It is shown that the resonances that may occur between harmonics of the particle circulation frequencies and the electromagnetic modes of the cavities can lead to a longitudinal instability of the beam. A criterion for stability of the beam against such longitudinal bunching is obtained as a restriction on the shunt impedance of the r-f cavity, or the Q of the vacuum tank. This criterion contains the energy spread and intensity of the coasting beam, as well as the parameters of the accelerator. Numerical examples are given which indicate that, in general, the resonances with the vacuum tank will not cause instabilities, while those with an r-f cavity can be prevented from causing instabilities by choosing the shunt impedance at a sufficiently low but still convenient value. (auth)

15117 THE MOTION OF IONS IN AN AXIAL MAGNETIC FIELD OF THE $H_z = H_1 r^{2s} - H_2 r^{2s+2}$ TYPE. M. I. Korsunskii. Trudy Khar'kov. Politekh. Inst., 14: 103-10(1958).

The motion of ions in axial magnetic difference-type fields of the $H_z = H_1 r^{2s} - H_2 r^{2s+2}$ type is investigated in order to find magnetic fields with a high dispersion and resolution power. The components H_z and H_r of the difference-type field are determined. Conditions for focusing a diverging ion beam are established. At the focusing spot the beam is decomposed into spectrum with a dispersion exceeding by one order the dispersion in a homogeneous magnetic field. A high degree of dispersion can be obtained for a difference-type field with various values of the s parameter. A difference-type field with parameters s = 0 has a minimum aberration for ions moving outside of the plane z = 0. Difference-type fields have the property of double focusing in direction (in z and in r). Conditions for double focusing are established. The form of the pole surfaces for obtaining the most significant particular case of the difference-type field (s = 0) is determined. (TCO)

15118 SOME ABERRATIONS OF AN ION BEAM WHEN PASSING THROUGH AN ELECTRIC FIELD OF THE $E_r = E_0 r^{-1}(1-kr^2)$ TYPE. V. A. Bazakutsa and M. I. Korsunskii. Trudy Khar'kov. Politekh. Inst., 14: 83-101(1958).

The motion of ions in an electrical field of the difference type, with the components $E_r = -E_0 r^{-1} \cdot (1-kr^2)$, $E_z = -2kE_0 z$, where E_0 and k are parameters of the field, is considered in the 2nd approximation. Insofar as the motion of the ions is considered near the equilibrium trajectory, the method of perturbations is applied to the solution of the problem. The calculation of the side shift of the ion beam from the equilibrium trajectory makes possible the establishment of its dependence on the inconstancy of the value of the ion energy (β), their angle of divergence (ψ_r) and the width of the input slit (Δr_0). The aberration coefficients have the highest value at β^2 and ψ_r^3. The aberration coefficients of a difference-type field are compared to the corresponding coefficients of a cylindrical field. If the dispersion of a difference-type field increases by one order compared to the dispersion of a cylindrical field, the aberration coefficients increase 100 times. The absolute aberration value of the difference-type field, however, is comparable to the dimensions of the slits usually employed in spectroscopy; an increase of dispersion in the difference-type field leads, therefore, to a practical increase of the resolution power. (TCO)

15119 THE SYSTEM FOR EXTREME REGULATING OF INTENSITY OF γ-RADIATION FROM SYNCHROTRON. A. P. Komar, G. F. Mikheev, and N. N. Chernov (Leningrad Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 109-15 (Jan. 1961). (In Russian)

Descriptions are given of a regulating system for the γ radiation intensity from a synchrotron. The system has two parameters, injection time and switching time of high-frequency voltage, on the synchrotron resonator. Specifications and operational data are included. (tr-auth)

Plasma Physics and Thermonuclear Processes

15120 (AD-245921) PLASMA PHYSICS OF SHOCK FRONTS. Research Report No. 7-801,3. M. P. Bachynski, I. P. Shkarofsky, and T. W. Johnston (RCA Victor Co., Ltd. Research Labs., Montreal). June 1959. 226p.

A summary of fundamental physics associated with plasmas formed by strong shock fronts is presented. The methods of quantum statistical thermodynamics, thermodynamics of real gases, and aerodynamics were applied to determine the particle constituents and thermodynamic properties of a plasma created by a strong shock wave. This enabled certain electrical and electromagnetic properties to be associated with the plasma. Variation of these plasma properties are given for air in thermal equilibrium. The effects of non-equilibrium, i.e., relaxation phenomena, are discussed. Finally, measurement techniques for determining shock front plasma properties are considered. (auth)

15121 (AERE-R-3383) PINCH COLLAPSE. K. Hain (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1961. 32p.

Mathematical methods for solving the numerical problems of pinch collapse were developed for the dynamical pinch where the inertia terms are not to be neglected. A fully ionized plasma to which cylindrically symmetric magnetic fields were applied was assumed. The plasma was treated in the hydromagnetic approximation including electric and thermal conductivity. The problem of treating a small diffusion term in an otherwise hyperbolic set of equations was solved by an approximate method. An explicit Eulerian scheme for fast pinches is given in which the timestep is bounded by the Alfven velocity. To avoid such a restriction for rather slow pinches an implicit scheme was developed. The method for solving the hydromagnetic set of equations consists of neglecting in each timestep the interaction between diffusion and the usual magnetohydrodynamic terms. (M.C.G.)

15122 (AFCRL-TN-60-982) PROPAGATION CHARACTERISTICS OF A MAGNETO-IONIC DUCT. D. Formato and A. Gilardini (Sindel S.p.A., Rome). Mar. 31, 1960. Contract AF 61(052)-145. 43p.

The propagation characteristics of a uniform magneto-ionic duct of circular cross-section are determined for signal frequencies smaller than the cyclotron frequencies. The ratios (plasma wave length)/(free space wave length) and (power flowing in the plasma)/(power flowing outside) and evaluated, and discussed as a function of the diameter/wave length ratio and of the plasma permittivity, for the

propagation of circularly symmetrical modes. The attenuation caused by the electron-molecule collisions and the propagation characteristics of all modes, for a plasma frequency much smaller than the signal frequency, are discussed. (auth)

15123 (NASA-TN-D-740) IONIZATION AND DEIONIZATION PROCESSES IN LOW-DENSITY PLASMA FLOWS. Raymond L. Barger (National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.). Apr. 1961. 21p.

Various plasma relaxation processes that are significant in laboratory plasma flows for aerospace physics studies are discussed on the basis of a survey of time decay studies of immobile plasmas. Some of the problems analyzed and discussed are: the relative importance of the various recombination mechanisms, catalytic deionization by electronegative particles, delayed ionization produced by metastable action, and heating of the flow by deionization reactions. (auth)

15124 (NP-9959) A TRANSPORT EQUATION FOR MAGNETOHYDRODYNAMIC WAVES. Research Report No. 92. Marvin M. Litvak (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Aug. 1960. Contract Nonr-2524(00). 90p.

The investigation deals with a plasma of electrons and ions at a density of 10^{16} particles per cc and temperature of 10^5 to 10^6 degrees K. There is a magnetic field of about 10^4 gauss whose pressure is about 10^1 or 10^2 times larger than the gas pressure. Attention is limited to physical phenomena occurring over lengths of the order of $r_i = \sqrt{m_i c^2/(4\pi ne^2)}$ which is about one centimeter or about 10^4 times larger than the Debye length. r_i, the largest characteristic length next to the particle mean free path, is the gyro-radius of ions which move at the Alfvén speed, the characteristic speed of magnetohydrodynamic (MHD) flows. The mean free path for multiple Coulomb scattering, the only particle collision process for these plasma conditions, is large so that diffusion and dissipation processes from particle collisions are slow. Experimental evidence exists which indicates high diffusion and dissipation rates. The processes are attributed to the diffusion and randomization of waves which are excited in the plasma. In particular, the important waves are the fast MHD waves, which are one of the six types of normal waves which are obtained from the Boltzmann equation with a self-consistent Lorentz force and no collision term. The fast waves were derived under the restrictions that the particle thermal velocities are unimportant, that the wavelengths lie between $r_i\sqrt{m_e/m_i}$ and r_i, and that the Maxwell displacement current is small. The fast waves are important because they are not heavily damped, and have phase and group velocities of the order of the Alfvén speed. The main effort is to derive a wave transport equation for the fast MHD waves which describes the motion of a wave in a non-uniform medium, the amplification of a wave because of the pressure of the surrounding medium, and the scattering of a wave by other waves. The equation resembles the transport equation for lattice waves in a crystal. The equations for the structure of a steady MHD shock are derived from the wave transport equation but not solved. The shock model is based on the assumption that behind the steady shock is a distribution of fast waves whose pressure is much greater than the gas pressure. The waves scatter with other waves and provide the entropy increase for the jump of conditions across the shock. The particles become thermalized only some distance further back of the shock by means of damping of wave motion into particle motion. Estimates of relaxation times for the wave collision processes are made, and an estimate of the shock thickness, as a function of shock velocity, is made assuming that it is a few wave mean free paths. (auth)

15125 (NP-9964) THE ELECTROMAGNETIC DETONATION CONCEPT. K. M. Foreman (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). [1961]. 26p.

Paper to be presented at the American Rocket Society Propellants, Combustion and Liquid Rockets Conference, Palm Beach, Fla., April 26, 1961. ARS Preprint 1702-61.

The linear pinch process results from the discharge of a high-frequency, large-magnitude electric current in a low-pressure gas contained in the cylindrical envelope of two parallel electrodes. The effect is to produce a sheath of plasma at the outer periphery of the cylinder (skin effect) which is forced to move radially inward by virtue of its self-induced magnetic field, in the manner of an inertialess magnetic piston. The motion of the electromagnetic piston in a combustible mixture produces a shock front, in advance of the piston, of sufficient strength to induce detonation. The electromagnetic and gasdynamic details of the concept of electromagnetic piston-supported are described. The required characteristics of the electrical power supply are specified. Some aspects of the experimental investigation will be discussed including the diagnostic equipment. Finally, speculations are advanced for the application of the concept to electrical atmospheric propulsion and MHD electric power generation devices. (auth)

15126 (NP-9966) PARAMETRIC STUDIES OF STRONG GASEOUS DETONATIONS. K. M. Foreman, H. Pevney, and R. MacMillan (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). [1961]. 27p.

An IBM 704 computer program used for a parametric study of gaseous detonations is described. In addition to being able to define the thermodynamic and gas dynamic properties of the equilibrium, one-dimensional process it is possible to investigate the energy released. On the basis that the net energy release of the detonation equals the changes of enthalpy and kinetic energy of the reactants as they change to reaction products, it is seen that exothermic reactions soon become overridden by endothermic processes as the strong detonation wave velocity increases. Thus, it becomes possible to define the limits of gaseous detonations by a composition (equivalence ratio)-velocity coordinate system for prescribed reactant temperature and pressure conditions. The lower velocity limit is the Chapman-Jouguet condition and the upper velocity limit is the zero energy release condition. Parametric studies of oxygen-hydrogen and air-hydrogen detonations were conducted for a wide range of initial temperatures and pressures. Typical variations of equilibrium product gas composition and temperature with wave velocity are presented and discussed. For oxygen-hydrogen detonations it was observed that the Chapman-Jouguet condition for the stoichiometric mixture produces the maximum energy release. The limits of detonations were broadened by higher reactant pressures and narrowed and shifted to lower velocities by higher reactant temperatures. Air-hydrogen detonations, however, showed larger energy release for leaner than stoichiometric mixtures, reaching a maximum at approximately an equivalence ratio of 4. However, the limits of air-hydrogen detonations displayed similar characteristics to the oxygen-hydrogen process. (auth)

15127 (PPL-TR-60-1) EFFECT OF MAGNETIC FIELDS ON THERMIONIC POWER GENERATION. Alfred

Schock (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Jan. 1960. 70p.

It is demonstrated that the high currents present in large thermionic power generators produce magnetic fields which have a strong adverse effect on electron transmission and energy conversion efficiency. A method for overcoming the adverse effect of the self-induced field is presented and analyzed. It is shown that the superposition of a magnetic field normal to the emitting surface will permit efficient operation of large power generators. (auth)

15128 (PPL-TR-60-21) A DC GLOW MODEL OF THE FORMATION OF THE MAGNETIC PISTON. L. Aronowitz and P. Mostov (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Dec. 1960. Contract AF49 (638)-552. 12p. (AFOSR-319)

The formation of the magnetic sheath or "magnetic piston" in a linear pinch discharge between metal electrodes was analyzed. In many regimes of practical interest, electrode effects may play a dominant role. The results of d-c discharge phenomena were incorporated into the analysis to account for these electrode effects. A method was developed to compute current density as a function of position and time in the early stages of a pinch discharge. (auth)

15129 (PPL-TR-61-1) ELECTROMAGNETIC DIFFUSION INTO A CYLINDRICAL PLASMA COLUMN DURING THE EARLY STAGES OF PINCH FORMATION. Joseph L. Neuringer, Lester Kraus, and Herbert Malamud (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Jan. 16, 1961. Contract AF49(638)-552. 38p. (AFOSR-TN-320)

The diffusion of electromagnetic energy into a cylindrical plasma column due to the discharge of the energy stored in a capacitor was formulated taking into account the effects of the capacitance and inductance of the discharge circuit. The discharge circuit reflected the linear pinch geometry in that the energy source was a charged condenser and the return lead was a perfectly conducting cylindrical shell concentric with and surrounding the plasma column. The plasma properties entered the formulation through an extended Ohm's law which includes the time rate of change of current density. Under the assumption that changes in the ionization density and collision frequency may be neglected, Maxwell's equations led to a third-order linear partial differential equation for the diffusion current. An exact solution was obtained by Laplace transform techniques using appropriate initial and boundary conditions which take into account the finite external circuitry. The spatial and temporal behavior of the current density distribution as functions of the parameters which characterize both the circuit and the plasma are discussed and compared with that of an ordinary conductor obeying the simple Ohm's law. (auth)

15130 (PPL-TR-61-4) SYNTHESIS OF CURRENT WAVEFORMS BY TYPE C NETWORKS. D. Rigney, L. Kraus, and H. Malamud (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Jan. 30, 1961. Contracts AF29(601)-2866 and AF49(638)-552. 23p. (AFOSR-321)

A theoretical analysis was performed which permitted synthesis of any required current waveform when the current was to be discharged through a load inductance, L_o. The synthesis was accomplished by forcing the characteristic modes of an LC network into correspondence with the harmonic components of the required waveform. Equations were derived which permitted solution for the required network parameters, and approximate solutions are given. An IBM 7090 program is available for use when more accurate solutions are required. The experimental synthesis of a current waveform is described. (auth)

15131 (PPL-TR-61-5) ELECTROMAGNETIC ACCELERATION OF A PLASMA SLUG. Philip M. Mostov, Joseph L. Neuringer, and Donald S. Rigney (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Feb. 24, 1961. 34p.

The slug model of a plasma accelerator was formulated and analyzed. The coupled non-linear system equations involving seven parameters were transformed into a three-parameter set. The formulation includes as special cases Artsimovich's treatment, which neglects all system resistances, and Schock's treatment, which assumes negligible resistance of the accelerator electrodes. Small coupling as well as small and large time asymptotic solutions, which include the effect of rail resistance, were derived and compared with exact analog computation. In cases of practical concern, the small time solutions are valid well past the first maximum of the current discharge, bridging the gap left by Schock's approximate solution whose applicability is restricted to cases where the acceleration takes place over a number of cycles. Finally, it is shown how to optimize the efficiency of an accelerator through suitable adjustment of the system parameters. (auth)

15132 (TID-11260) EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES: CHALICE. Progress Report No. 1, June 1, 1960 through November 30, 1960. Samuel Koslov and George Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). Contract AT(30-1)-2582. 22p. (SIT-P28(12/60))

Design philosophy and development status are reviewed for CHALICE [Compression, Heating and Linear Injection Cusp Experiment]. The system was assembled and is undergoing preliminary testing. Auxiliary experiments were conducted to investigate the behavior of preheated plasmas in cusped fields using relatively low quasi-static fields and gun injection within the field. (B.O.G.)

15133 (TID-12326) LIGHT AS A PLASMA PROBE. Technical Report No. 7. Michel Baranger (Carnegie Inst. of Tech., Pittsburgh) and Bernard Mozer (Brookhaven National Lab., Upton, N. Y.). [1960]. Sponsored by AEC and ONR under Contract Nonr-760. 20p.

The effect of longitudinal plasma oscillations on atomic spectra was examined. It is shown that these oscillations should give rise to satellite lines, disposed symmetrically in pairs about a forbidden line and separated from it by the plasma frequency. The circumstances under which these satellites should be strong enough to be observed are discussed. Their observation would amount to a measurement of the frequency and intensity of plasma oscillations. (auth)

15134 (UCRL-5888(Rev.)) TURBULENCE IN PLASMAS. Stirling A. Colgate (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 16, 1961. Contract W-7405-eng-48. 13p.

The observed turbulence in a pinch was investigated from the standpoint of enhanced diffusion both of runaway electrons and of the bulk plasma. A resistivity was derived based upon equal diffusion rates for ions and electrons: $N_\perp = 8 \times 10^9 B\beta^2/n$ ohm-cm, where β is the turbulent pressure divided by the field pressure. The most important frequency and wavelength became, respectively, the ion cyclotron frequency and ion Larmor radius. (auth)

15135 (UCRL-6176) IONIZATION IN CROSS ELECTRIC AND MAGNETIC FIELDS. Stirling A. Colgate (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 15, 1961. Contract W-7405-eng-48. 18p.

Both in magnetohydrodynamic shocks and in accelerated artially ionized gas flow across a magnetic field, space harge separation occurred that established very large elec- ric fields in the direction of motion. The width of the cur- ent layers associated with the acceleration was never less nan the electron Larmor radius with no collisions and was roadened by electron collisions to a width solely determined y the effective resistivity. The electrons gained an energy egardless of collisions equal to the electric potential dif- erence across the layer. For $\omega\tau < 1$, (ω = electron cyclo- ron frequency, τ = collision time) this potential corre- sponded to the change in kinetic energy of mass motion per on. For slightly ionized gases, the additional stress of eutral ion collisions within the layer could make the elec- ric potential and hence the gain in electron energy very arge for only modest changes in mass velocity. Hence ion- zation may occur when the change in kinetic energy of the ons is small compared to the ionization potential. (auth)

15136 (UCRL-6196) A PARTIALLY DEGENERATE, RELATIVISTIC, IDEAL ELECTRON GAS. William H. Grasberger (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 23, 1961. Contract W-7405-eng-48. 47p.

Tables of the electron pressure and kinetic energy for a partially degenerate, relativistic, ideal electron gas were computed by numerical integration using an IBM 7090 electronic calculator. These are given in terms of $\log_{10}\beta$ and $\log_{10}\phi$, where β is the ratio of the temperature to the rest mass of the electron and ϕ is proportional to the numerical density of electrons. The tables include values of T from 5 million to 400 billion degrees and cover the range of electron densities from the region of a perfect gas to the region of complete degeneracy. (auth)

15137 (UCRL-6351) THE STATUS OF RESEARCH IN THERMONUCLEAR POWER. Stirling A. Colgate (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 28, 1961. Contract W-7405-eng-48. 18p.

A discussion is given on the advancements in thermonuclear research. Illustrations are given of toroidal pinch, magnetic mirror confinement, the stellarator, the levitron, pressure anisotropy instability, and multistage mirror compression. (B.O.G.)

15138 (AEC-tr-2616) INVESTIGATION OF HIGH FREQUENCY DISCHARGES BY THE PROBE METHOD. Kh. A. Dzherpetov and G. M. Pateyuk. Translated from Zhur. Eksptl'. i Teoret. Fiz., 28: 343-51(1955). 9p.

A comparison is made of probe methods for investigating high-frequency discharges. Measurements are made by the two-probe method, and by a one-probe method with the use of a counterprobe. The results show that both methods give the same results for the electron temperature within the limits of experimental error. The use of a counterprobe as a reference point leads to an insignificant redistribution of the electrical parameters of the high-frequency discharge along the axis of the tube. An investigation is made of the dependence of temperature, electron concentration, and space potential at the axis of the discharge tube on the pressure of the gas. The distribution of temperature, electron concentration, and space potential along the axis of the tube are obtained. In a uniform high-frequency discharge these parameters are symmetric with respect to the electrodes and have their maximum values between the electrodes. The distributions along the tube depend essentially on the gas pressure, diameter of the discharge tube, and high-frequency field intensity. (auth)

15139 (AEC-tr-3972(p.446-524)) MAGNETOHYDRODYNAMICS. S. I. Syrovatskii. Translated from Uspekhi Fiz. Nauk, 62: No. 3, 247-303(1957).

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, Abstract no. 12086.

15140 (AEC-tr-4070) INVESTIGATION OF THE POSSIBILITY OF OBTAINING STATIONARY MAGNETIC FIELDS IN COILS COOLED BY LIQUID HYDROGEN. E. S. Borovik, F. I. Busol, and S. F. Grishin. Translated for Lawrence Radiation Lab. from a paper furnished by Soviet scientists on the occasion of their visit in May 1960. 17p.

Production of large stationary magnetic fields entails large energy losses, and reduction of these losses would facilitate the accomplishment of a thermonuclear reaction with useful energy yield. This loss reduction can be attained by lowering the temperature of the coils creating the magnetic field, and the possibility of using liquid hydrogen to cool magnetic coils was experimentally investigated. The maximal allowable heat loading per unit surface in single-layer coils and their priming coefficients were determined under both natural convection and forced flow conditions. The time dependence of the magnetic field was also determined for various thermal loadings. The results show that in principle, fields of up to 10^5 gauss are possible with the use of pure aluminum (brand AB-0000) for large coils on the order of 1 meter. (D.L.C.)

15141 (AEC-tr-4170) EIGEN OSCILLATIONS OF A BOUND PLASMA. D. A. Frank-Kamenetskiĭ. Translated for Oak Ridge National Lab. from a paper furnished by the Soviet scientists on the occasion of their visit in May 1960. Zhur. Eksptl'. i Teoret. Fiz. 39: 669-79(1960). 24p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 3561.

15142 (AEC-tr-4182) INVESTIGATION OF TOROIDAL DISCHARGE IN A RAPIDLY VARYING LONGITUDINAL MAGNETIC FIELD. D. P. Ivanov and V. D. Kirillov (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoĭ Energii). (Translation). 23p. Also Published in Doklady Akad. Nauk S.S.S.R., 133: 793-6(1960). 21p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 5737.

15143 (AEC-tr-4189) INVESTIGATION OF A TOROIDAL DISCHARGE IN A STRONG MAGNETIC FIELD. E. P. Gorbunov, G. G. Dolgov-Savel'ev, V. S. Mukhovatov, V. S. Strelkov, and N. A. Yavlinskiĭ. Translated from a paper furnished by Soviet scientists on the occasion of their visit to Project Matterhorn in May 1960. 26p.

Experiments on the heating and stability of a plasma ring with a current in a strong longitudinal magnetic field are described. The experiments were carried out on the toroidal apparatus "Tokomak-2," the discharge chamber of which was heated to temperatures of 400 to 450°C. It is shown that improvement of vacuum conditions and degasification of the walls lead to a change in the character of the process. A second maximum of current and oscillations of the discharge current with a frequency of 10 kilocycles and higher were observed. The temperature of the electrons, determined with respect to the electrical conductivity of the plasma, was about 30 electron volts at the close of the process. (auth)

15144 (AEC-tr-4280) MAGNETIC TRAP WITH ROTATING PLUGS. L. I. Rudakov (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoĭ Energii). Translation. 1960. 12p.

It was found that if electromagnetic oscillations of large amplitude are excited in a plasma, filling the trap with static magnetic plugs, then an additional force, which opposes the escape of particles from the trap will act on the plasma particles in the region of the plugs. It is shown that in this manner the escape cone of the particles can be

closed. The retention of plasma in the trap with magnetic plugs and the excitation of electromagnetic oscillations with elliptical polarization is possible, provided the condition $(H^2\sim)/(8\pi)\ 0 > nT$ is satisfied. (M.C.G.)

15145 (AFCRL-20) ON THE QUESTION OF THE HEAT CONDUCTION OF A FULLY IONIZED PLASMA. Yu. (Iu.) A. Pekar. Translated from Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 99-102(1960). 5p.

Electron and ion temperature distributions are obtained for a fully ionized plasma bounded by parallel heat-eliminating walls, under the condition of constant current density across the cross section in the two limiting cases of strong and weak anisothermy. (auth)

15146 DETERMINING ELECTRON DENSITY AND DISTRIBUTION IN PLASMAS. Harlin L. Bunn (Univ. of California, Livermore). Electronics, 34: No. 14, 71-5(Apr. 7, 1961).

Methods were developed for determining plasma electron density and density distribution with microwave interferometer systems. The methods could be extended to ionized missile wakes and to such microwave components as harmonic generators, electronically controlled phase shifters, switches, and other devices derived from a waveguide filled with ionized gas. (N.W.R.)

15147 PRODUCTION AND ANALYSIS OF A LARGE-DIAMETER PLASMA BEAM. B. B. Meckel and P. A. Harkins (Convair, San Diego, Calif.). J. Appl. Phys., 32: 489-93(Mar. 1961).

A continuously operating low-velocity plasma accelerator is described which has a beam diameter of 3.6 cm. The beam is produced by extracting ions from a discreetly generated singly charged ion plasma in the following manner: A fine wire mesh placed so that one side is exposed to the plasma acts as a solid flat cathode when given a negative potential. Some of the ions which are attracted to the mesh pass between the wires and stream into the region behind the mesh where they enter a field of thermionically emitted electrons. The resulting beam consists of a stream of parallel-flowing ions with a compensated negative space-charge atmosphere of randomly moving electrons. Beam densities of 2×10^8 ions/cm^3 of 100-ev Hg^+ ions are obtainable 15 cm from the extractor. Gas pressures are maintained which provide mean free paths which are long compared to the tube dimensions. The diagnostic techniques used to analyze the beam parameters are described. The system is versatile and may be altered to permit the use of other gases, pressures, and ion velocities. (auth)

15148 EFFECT OF HYDROMAGNETIC WAVES IN A DIPOLE FIELD ON THE LONGITUDINAL INVARIANT. E. N. Parker (Univ. of Chicago). J. Geophys. Research, 66: 693-708(Mar. 1961).

Hydromagnetic wave violation of the longitudinal invariant of a particle trapped in a mirror magnetic field is investigated quantitatively. It is shown that the passage of hydromagnetic waves across the region of mirroring leads to a diffusion of the individual-particle mirror points. If the relative wave amplitude $\Delta B/B$ is maintained throughout the mirror field, particles released in the field will soon diffuse out through the mirror and be lost. Application to thermonuclear devices is obvious. Confining our attention principally to the charged particles trapped in the geomagnetic field, it is shown that high-energy (10^5-ev) electrons in the outer Van Allen radiation zone are caused to diffuse along the lines of force with a characteristic time of 4 months by hydromagnetic waves of 1 cps and an amplitude of 10^{-4} gauss. Hydromagnetic diffusion appears to be more important than collisions in determining the electron lifetime and distribution in the outer Van Allen radiation zone. Different wave distributions along the lines of force can give radically different particle distributions. It is shown that, if the hydromagnetic disturbances extend throughout the geomagnetic field, then, rather than yielding particle acceleration, they result in a net loss of particle energy. But if we assume a region of hydromagnetic disturbance localized inside the geomagnetic field, limited particle acceleration may result. (auth)

15149 CONDUCTIVITY TENSOR OF A HOT, HOMOGENEOUS, AND WEAKLY IONIZED PLASMA. A. Mangeney (Institut d'Astrophysique, Paris). J. phys. radium, 21: 870-2(Dec. 1960). (In French)

The results of Bayet, Delcroix, and Denisse, presented in the first of a series of four papers published in the Journal de Physique, 15: 795(1954), are extended to the case of a Lorentz gas, the electronic temperature of which is high enough to justify a relativistic treatment. It is shown that the electric conductivity in the direction of the magnetic field is the same as in the paper of Bayet, Delcroix, and Denisse. The new expressions of the transverse conductivities are given. If the frequency of the electric field is less than the gyromagnetic frequency of the electrons, the method used is valid only for a class of electronic distribution functions. (auth)

15150 THE EFFECT OF THE PLASMA OSCILLATION ON THE ELECTRON-ION COLLISIONS. Sachio Hayakawa (University of Kyoto, Japan). Kaku Yugo Kenkyu, 1: 524-5 (December 1958). (In Japanese)

The electrostatic potential produced by plasma oscillation tends to reduce the speed of the electrons, thereby increasing the frequency of collisions. This phenomena is used to explain partially the unusually short relaxation time in plasma. An approximation of the relaxation time, including the effect of the interaction of the oscillation with the electrons, gives a value which is roughly 0.6 times the relaxation time without the interaction. The approximation is inadequate when the electrons come to a complete standstill at the maxima of the plasma wave amplitude and cause the Born approximation for the cross section to fail. When the imbalance of energy of the ions per cycle is assumed to be proportional to m/M, the relaxation time is m/M times the inverse of the plasma frequency. This formula gives 10^{-3} sec for the relaxation time of an argon discharge tube with electron density of 10^{10} cm^{-3}. It gives 10^{-4} sec for the deuteron plasma at a high temperature with electron of 10^{14} cm^{-3}. (JPRS)

15151 INTERACTION OF ELECTRONS WITH ION OSCILLATIONS IN PLASMA. Hideo Nakahato and Ichio Yamata (University of Nagoya, Japan). Kaku Yugo Kenkyu, 1: 526-31(December 1958). (In Japanese)

The scattering of electrons by collective oscillations of ions was investigated as a mechanism of relaxation in plasma. The relative importance of such scattering in the relaxation phenomena was determined on the basis of the formalism developed by Bardeen and Pines in connection with electron-photon interaction in metals. The effect of shielding of the positive charge polarization by the electrons was taken into account in setting up the hamiltonian for the case of a wavelength larger than the Debye radius. The time-dependent change of electron energy distribution was obtained by calculating the transition probability according to the usual formalism in the theory of metals, assuming that the electrons obey the Boltzmann statistics. Under the assumption that the electrons are in thermal equilibrium, relaxation time due to the interaction of electrons with the

collective motion of ions was calculated for the case of the ion number density of 10^{12} cm^{-3} and temperature of $10^{6°}$K. The value is 10^2 larger than the relaxation time, due to the random motion of ions calculated by Spitzer's formula. The assumption of the electrons in thermal equilibrium can be wrong when the frequency is lower than the reciprocal of self collision time. Then, the coulomb interaction should be calculated on the basis of the "undressed" electrons. In either case the contribution of electron scattering by collective oscillation of the ions to the relaxation phenomena can not exceed the contribution of random movement of the ions (JPRS)

15152 THEORY OF ELECTRON PLASMA OSCILLATION. Masao Kaku (Communication Laboratory). Kaku Yugo Kenkyu, 1: 532-41(December 1958). (In Japanese)

The various observed phenomena of electron plasma oscillation were investigated theoretically on the basis of a simplified model. The accelerated electrons were assumed to have acquired uniform velocity, and the plasma medium was assumed to have uniform density and maxwellian velocity distribution. The plasma was limited to a space bounded by two parallel and perfectly reflecting surfaces with a given separation. The basic equation was obtained by use of Boltzmann's equation for the electron velocity distribution and Poisson's equation for the electric field. The effect of short-range collisions on oscillation was neglected. The initial value problem of the linearized equation was solved by Fourier transformation of the space part and Laplace transformation of the time part after Landau. The excitation of various modes and the phenomena of mode- and frequency-jump are predicted on the basis of this model. The observation of standing waves in ion-sheath by Looney and Brown, so far attributed to a klystron-like mechanism, is reinterpreted in terms of the new model with success. The model also gives a satisfactory explanation of the observation of a standing wave between the cathode and a plane probe by Bailey and Emeleus. The good agreement of the prediction of this simplified model and experimental results is an indication that loss due to reflection of the plasma wave in the sheath is small when electron scattering is not excessive. Agreement with experiments by Wehner and Kojima et al. is less satisfactory, but appears to improve when the effect of the density variation is taken into account. (JPRS)

15153 EQUILIBRIUM CONFIGURATION OF MAGNETO-FLUIDS. Shigeo Hamade (Nihon University). Kaku Yugo Kenkyu, 1: 542-62(December 1958). (In Japanese)

A new formalism is presented for the hydromagnetic equilibrium of magneto-fluids with infinite electrical conductivity. A proper coordinate system was constructed out of the direction of current, magnetic induction field, and isobaric surfaces, with the origin on an arbitrary isobaric surface. The volume element was constant over an isobaric surface. Other properties of the curvilinear coordinate system are discussed. The necessary condition for the confinement of the plasma between two isobaric surfaces can be obtained from a variational principle. The condition reformulates in hydromagnetic terms the requirement of a no-charge separation in the conventional orbit theory. The equation of a state at equilibrium was recast in the proper coordinate system, which helped the visualization of the equilibrium configuration. A few general results were obtained without solving the equations. A scheme of successive approximations with given boundary conditions is outlined. (JPRS)

15154 COLLECTIVE DESCRIPTION OF IONIZED GASES. Ichio Yamata and Hideo Nakahato (University of Nagoya, Japan). Kaku Yugo Kenkyu, 1: 563-7(December 1958). (In Japanese)

Under the assumption that the deviation from the thermal equilibrium is small for electrons, separation of collective motion of electrons from collective motion of ions in the interaction hamiltonian can be achieved by borrowing the method of the electron theory of metal. Such calculation reaffirmed the result of the more intuitive method that collective motion of the plasma suppresses the long-range scattering due to Coulomb interaction in a plasma of high temperature and low density, but plays a small role in the relaxation phenomena so far as the cut-off collision parameter in the calculation of the collision cross section is of the order of Debye radius. (JPRS)

15155 TOROIDAL MAGNETIC BOTTLE (1). Chihiro Okawa (University of Tokyo). Kaku Yugo Kenkyu, 1: 568-82 (December 1958). (In Japanese)

The prevention of the drift of particles in the axial direction of a toroidal magnetic bottle was investigated by the single-particle orbit theory. Displacement of the particle in the axial direction per rotation was calculated for a two-dimensional problem where the magnetic field is independent of the coordinate in the axial direction. A necessary condition for the confinement of particles in a bottle like a stellarator is given in an integro-differential equation for the general case of an arbitrary magnetic field. Such a necessary condition was solved in an analytical form for one typical magnetic field of toroidal configuration. Simplified calculation of a condition for eliminating the drift effect due to a dipole charge separation in a toroidal discharge tube is outlined. Finally, a discharge tube consisting of four toroidal sections is discussed as a design suitable to eliminate drift due to the quadrupole charge separation. (JPRS)

15156 CONTROLLED THERMONUCLEAR REACTION RESEARCH AT THE ATOMIC ENERGY INSTITUTE OF THE ACADEMY OF SCIENCE OF THE U.S.S.R. I. V. Kurchatov [Kurcatov]. Kaku Yugo Kenkyu, 1: 583-90(December 1958). (In Japanese)

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, as abstract no. 2855.

15157 TRANSPORT PATH LENGTH IN PLASMA. R. W. Larenz (Technische Hochschule, Hanover). Naturwissenschaften, 48: 40(1961). (In German)

The deviation or scattering of induced charges in the Coulomb field, calculated on the basis of the Kepler hyperbola of the two-body problem, leads to an expression for the transport path length. The deviations of induced charges was also calculated on purely statistical considerations, from which another expression for the transport path length was derived. The validity of these two expressions is discussed. (J.S.R.)

15158 EXPERIMENTS WITH ELECTRODELESS GENERATION AND ACCELERATION OF PLASMA RINGS. L. Hogberg and K. Vogel (Univ. of Uppsala). Nuclear Instr. & Methods, 10: 95-107(Feb. 1961). (In English)

The design and performance of an electrodeless plasma gun is described. The driving circuit consists of a capacitor feeding a single primary turn, placed behind the flat end wall of a Pyrex tube. Max. primary current is 65 kamp. with a risetime of 0.35 μs. The discharges are studied by means of magnetic pick-up loops, a Kerrcell camera, and by spectroscopical measurements. Plasma rings of comparatively high purity and with velocities up to 5 cm/μs are produced. By means of a longitudinal magnetic field, strength up to 1200 gauss, the burst of plasma is contracted to the center of the tube. (auth)

15159 X-RAY CONTINUA AND LINE SPECTRA FROM HIGHLY STRIPPED ATOMS IN A MAGNETICALLY COMPRESSED PLASMA. A. J. Bearden, F. L. Ribe, G. A.

Sawyer, and T. F. Stratton (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 6: No. 6, 257-60(Mar. 15, 1961).

A single-crystal time resolving x-ray emission spectrometer is described for study of x-ray spectra from the Scylla fast magnetic compression experiment. The Scylla sinusoidally oscillating magnetic field achieves a value of 55 kgauss in 1.25 μsec, producing a deuterium plasma. The spectra of O^{VIII}, Na^{X}, Mg^{XI}, Al^{XII}, and Si^{XIII} impurities are studied from 5 to 15A in D plasmas; in addition, the Ne^{VIII}, Ne^{IX}, $Ne^{X}L_{\alpha}$, and $Ne^{X}L_{\beta}$ spectra are studied for plasmas of 90% D and 10% Ne. During the half-cycle of decreasing magnetic field, an x-ray continuum is produced; the properties of this continuum, including the electron temperature, are studied. (auth)

15160 DIFFUSION OF PLASMA ACROSS A MAGNETIC FIELD. J. B. Taylor (Atomic Weapon Research Establishment, Aldermaston, Berks, Eng.). Phys. Rev. Letters, 6: No. 6, 262-3(Mar. 15, 1961).

The diffusion of a plasma across a magnetic field is calculated allowing a non-Maxwellian distribution, such as is found when electron and ion temperatures are unequal. The expression obtained for the diffusion is shown to reduce to the classical expression when the non-Maxwellian distribution is replaced by a Maxwellian distribution. The classical diffusion is proportional to B^{-2}; it is shown that the diffusion can never be proportional to any higher power of B than -1 (i.e., diffusion $\sim B^{n}$, $n \leq -1$). (T.F.H.)

15161 THE IONIC CENTRIFUGE AND FUSION NUCLEAR POWER. Joseph Slepian. Proc. Natl. Acad. Sci. U. S., 47: 313-19(Mar. 1961).

The Ionic Centrifuge is briefly described. The discharge in this device violates the usual rules of magnetohydrodynamics because of the high electric field parallel to the magnetic field in the space charge affected boundaries.[6,8] The kinetic energy of random motion of the particles is proportional to the voltage which the main discharge holds at each point. By causing this voltage to rise to a high positive value and then drop to zero at the cylinder, the ions are not collected when their kinetic energy is high, but only at the cylinder where this kinetic energy is low again. The suitability of this arrangement for nuclear power converters is pointed out. (auth)

15162 EXCITATION OF MECHANISM OF ELECTRON PLASMA OSCILLATIONS. M. D. Gabovich (Inst. of Physics, Academy of Sciences, USSR). Radiotekh. i Elektron., 6: 178-9(1961). (In Russian)

The klystron mechanism of plasma oscillation excitation is analyzed and various experiments on the mechanism of electron plasma oscillation are discussed. It is also shown that the klystron mechanism, supplemented by coherent interactions of electron clusters with plasma, can be used to describe many observed oscillation characteristics. No uniform explanation for all experimental observations has been found, however, the existence of a TWT mechanism (spatial interaction of electron flux with plasma) is accepted. This does not exclude excitation of oscillations resembling the klystron excitation. (R.V.J.)

15163 PIEZOELECTRIC PROBE FOR PLASMA RESEARCH. Martin O. Stern and Edward N. Dacus (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instr., 32: 140-3(Feb. 1961).

A piezoelectric probe was devised for use in plasma work in order to measure phenomena of short-time duration (μsec) giving rise to moderately small pressures (fractions of an atmosphere). Some of the response characteristics of such a probe and a method for its calibration are also presented. (auth)

15164 EXCITATION OF ELECTROMAGNETIC OSCILLATIONS IN A PLASMA BY AN ELECTRONIC BEAM. V. L. Bulat. Uchenye Zapiski, Moskov. Gosudarst. Zaoch. Pedagog. Inst., Ser. Fiz.-Mat., No. 3, 240–51(1959).

Investigations were carried out on electromagnetic oscillations originating in a plasma excited by an electronic beam in a long and narrow tube with a gas pressure of 10^{-1} to 10^{-3} mm Hg. The frequency and intensity of the oscillations is mainly determined by the value of the discharge current, the pressure, and the nature of the gas. The frequency range of the oscillations generated lies within the limits of 10^{4} to 10^{5} cps, due to which fact the radiation observed cannot be attributed to the oscillations of the electrons or the ions of the plasma proper. An attempt is made to explain the oscillations of an unsteady electric discharge in the tube, which are alternating sparks and extinctions. (TCO)

15165 THEORY OF BREMSSTRAHLUNG IN HYDROGEN PLASMA WITH CONSIDERATION OF THE GAUNT FACTOR. Herbert Schirmer (Osram-Studiengesellschaft, Berlin). Z. angew. Phys., 13: 56-9(Feb. 1961). (In German)

The effect of the Gaunt factor on the emission, absorption, beam density distribution, and output coefficient of the bremsstrahlung of a hydrogen plasma was represented by the exact theory of Sommerfeld over a wide frequency range. The numerical data lead to calculations and developments of Berger, Hettner, Kummerer, and Guggenberger. The recombination radiation of a hydrogen plasma in relation to the bremsstrahlung was also considered in dependence on the temperature. (tr-auth)

15166 FULLY IONIZED PINCH COLLAPSE. K. Hain (Max-Planck-Institut für Physik und Astrophysik, Munich), G. Hain, K. V. Roberts, S. J. Roberts, and W. Köppendörfer. Z. Naturforsch, 15a: 1039-50(Dec. 1960). (In English)

A fully ionized plasma is assumed. To this plasma cylindrically-symmetric magnetic fields are applied thus causing a pinch collapse. The plasma is treated in hydromagnetic approximation, including electric and thermal conductivity. Separate temperatures are assigned to the electrons and ions. Two schemes are developed for solving numerically the resulting system of six partial differential equations: the explicit scheme for rather fast pinches, where a numerically stability requirement causes the timestep to be bounded by the characteristics given by the Alfvén speed, and an implicit scheme, which consists essentially in converting the momentum equation into a second-order difference equation with coefficients determined by iteration; here there is no such restriction on the timestep. These schemes were made to work on the U.K.A.E.A. IBM 704 and IBM 709. A run is described in which the initial state was one with uniform density, temperature, and B^{z} field. The boundary temperatures were assumed to remain constant, while the magnetic fields at the boundary were determined by the circuits for the j^{z} and j^{Θ} currents. The results of the computations are in good agreement with experimental results obtained at the Technische Hochschule München by one of the authors (Köppendörfer). The whole program is a joint effort between A.E.R.E. Harwell and the Max-Planck-Institut, intended to discover by comparison with experiments how good the hydromagnetic approximations are. If the agreement is satisfactory (eventually using a generalized program which includes neutral gas) it should be possible to design experiments so that specified field configurations are set up. (auth)

15167 INVESTIGATIONS ON LINEAR PULSE DISCHARGE. W. Frie, H. Maecker, A. Michel, H. Motschmann, and H. Schindler (Siemens-Schuckertwerke, Erlangen, Ger.). Z. Naturforsch., 16a: 121-6(Jan. 1961). (In German)

With a pulse current battery on 1030 μF, 15 kv charge voltage and 4×10^{-9} H self-inductivity current increase velocities up to 1.5×10^{12} amp/sec, maximum currents of 1.2×10^{6} amp were obtained in a discharge vessel 38 cm in diameter and 45 cm high. Time-resolved curves of the discharge cross section and time-resolved spectra were derived. The cross section curves show during the ignition path a glow of the total volume from which the contraction phase results after a dark phase. The discharge distributed after the ignition over the total cross section was displaced by the skin effect to the wall and then driven through the Forentz force to the axis. Correspondingly, the self-induction sinks, after ignition, to a minimum, in order to increase later. The discharge spectrum shows, especially at high pressures, intensive continua during contraction, to which the line emission of the wall material is later added. Probe measurements permit the determination of length of maintenance of the axial symmetry and show the existence of eddy currents in the axis plane within the discharge. Measurements of the magnetic flux show that up to the beginning of the wall separation the largest part of the discharge energy was used for the building of the magnetic field. Below 6×10^{-2} Torr x-ray and neutron emissions occur. X-ray emission of 100 kv mean equivalent voltage, in addition to a pulse in the discharge ignition, was recorded during each contraction. A neutron pulse of more than 10^{7} neutrons was observed after the second contraction simultaneously with the spiral instability. (tr-auth)

15168 ON ELECTROMAGNETIC WAVE STABILIZATION OF LOCALIZED AND MOVING PLASMA BUNCHES. V. V. Yankov (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz., 30: 1019-23(Sept. 1960). (In Russian)

The dynamics of an infinitely conducting small spherical plasma bunch in electromagnetic fields, excited in resonators and waveguides, is studied. (tr-auth)

15169 STABILITY OF THE FLUID CYLINDER OF FINITE CONDUCTIVITY WITH CURRENT. S. N. Breus. Zhur. Tekh. Fiz., 30: 1030-4(Sept. 1960). (In Russian)

The current pinch stability in a magnetic field is studied under conditions where the magnetic field is not frozen into the conductor. It is shown that in such a case the instability is amplified with the increase of the longitudinal magnetic field. (tr-auth)

15170 EQUATIONS FOR THE MAGNETIC PLASMA DYNAMICS. A. I. Gubanov and Yu. P. Lun'kin (Leningrad Inst. of Physics and Technology). Zhur. Tekh. Fiz., 30: 1046-52(Sept. 1960). (In Russian)

Equations are derived for plasma motion and heat flow in a magnetic field at arbitrary $\omega\tau$. The equations are expressed by hydrodynamic velocity components and current and temperature gradient in a coordinate system where the magnetic field is directed along one of the axes and in an arbitrary Descartes system. (tr-auth)

15171 COUETTE STREAM IN THE MAGNETIC PLASMA DYNAMICS. A. I. Gubanov and Yu. P. Lun'kin (Leningrad Inst. of Physics and Technology). Zhur. Tekh. Fiz., 30: 1053-60(Sept. 1960). (In Russian)

Equations for viscous plasma motion in a magnetic field at arbitrary $\omega\tau$ were resolved for the simplest instance of couette flow. Cases of magnetic fields perpendicular and parallel or at arbitrary position to the plates are discussed. Plasma flow peculiarities, which are not inherent to magnetic hydrodynamics (in which $\omega\tau \ll 1$), were uncovered. (tr-auth)

15172 ABOUT PLASMA ACCELERATION IN COAXIAL SYSTEM. A. I. Morozov and L. S. Soloviev. Zhur. Tekh. Fiz., 30: 1104-8(Sept. 1960). (In Russian)

Equilibrium configurations are derived in hydrodynamic approximation for the plasma blob in a coaxial system. The instability of the configurations is described, assuming conditions of ideal conductivity. (tr-auth)

15173 ON THE STATIONARY STATE OF FINE RING PLASMA CYLINDER WITH FINITE CONDUCTIVITY. Yu. V. Vandakurov (Inst. of Physics and Technology, Academy of Sciences, USSR). Zhur. Tekh. Fiz., 30: 1134-6(Sept. 1960). (In Russian)

An attempt was made to find the drift compensation for toroidal-shaped plasma column. (R.V.J.)

15174 THE CALCULATION OF ELECTRODYNAMIC PUSH OF A NON-DEFORMED PLASMA RING OUT THE MAGNETIC MIRROR. E. M. Moroz and I. S. Shpigel (Lebedev Inst. of Physical Chemistry, Moscow). Zhur. Tekh. Fiz., 31: 78-83(Jan. 1961). (In Russian)

Equations of motion for ideally conducting and non-deformed convolution motions in a magnetic mirror vortex field were numerically integrated. The relationship between the energy of the incoming convolution and the bond coefficient and the relation between the active and parasitic inductions in the accelerating system were found. (R.V.J.)

15175 THE EXCITATION OF ION CYCLOTRON OSCILLATIONS IN PLASMA WITH THE ELECTRON BEAMS. O. A. Glazov, L. V. Dubovoĭ, and B. N. Rutkevich (Kharkov Inst. of Physics and Tech.). Zhur. Tekh. Fiz., 31: 84-6 (Jan. 1961). (In Russian)

An effective method of excitation is suggested for ion cyclotron oscillations in plasma. A modulated electron beam is passed through the plasma and converted into electron clusters which spiral with a $v_{||}$ velocity along the magnetic field. Such oscillation excitation was examined in hydrodynamic approximation, considering the gravitational forces negligibly small, the electric conductivity infinite, the pressure zero, a plasma consisting of electrons with mass m_e and charge e, and one type of positive ion with mass m_i and charge Ze. In a nonexcited state the plasma is electrically neutral, i.e., $n_i Z = n_e$. (R.V.J.)

15176 BIBLIOGRAPHY ON PLASMA PHYSICS. A. REPORTS AND CONFERENCES. (Max-Planck-Institut für Physik und Astrophysik, Munich). Feb. 1, 1960. 272p. (AED-BRD-C-03-1). (In German)

A bibliography on plasma physics is presented. Part one includes reports and conferences. Part two contains the journal literature. Over 3000 separate references are given. The third part gives indexes of report numbers, journals, other bibliographies, NSA abstract numbers, firms and institutions, authors, and subjects. (M.C.G.)

15177 BIBLIOGRAPHY ON PLASMA PHYSICS. B. JOURNAL LITERATURE. (Max-Planck-Institut für Physik und Astrophysik, Munich). Apr. 15, 1960. 256p. (AED-BRD-C-03-2). (In German)

15178 BIBLIOGRAPHY ON PLASMA PHYSICS. INDEX. (Max-Planck-Institut für Physik und Astrophysik, Munich). June 1, 1960. 131p. (AED-BRD-C-03-3). (In German)

15179 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Peter Clive Thonemann, Anthony Emerson Robson, and Roger Norman Hall (to United

Kingdom Atomic Energy Authority). British Patent 861,725. Feb. 22, 1961.

A toroidal gas discharge apparatus is designed in which the tendency to form arc spots is reduced. Following Patent No. 838,551, the apparatus has a surface exposed to the discharge formed of a plurality of closely spaced, mutually insulated thin metallic plates mounted edge-on to the discharge. The edge dimensions and spacing of the plates are such that the effective area of each plate exposed to the discharge is less than that required to maintain a unipolar arc. (D.L.C.)

Shielding

15180 (TID-11910) SHIELDING COMPUTER PROGRAM 20-0. J. E. MacDonald and J. M. Martin (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati) Oct. 21, 1960. 97p. (DC-60-10-98)

Program 20-0 generates and writes on tape source particle parameters to be used as input for Monte Carlo shield programs of the 18 series designed for analysis of reactor-shield assemblies. Source particles are generated in source tubes defined by right circular cylinders with mutually parallel axes of symmetry. A special case arises when the entire reactor is treated as a single source tube. The case of a point source can also be handled. Source particle spatial coordinates are chosen from appropriate power and power density distributions by one of two methods; a random method based on uniformly distributed random numbers, and a systematic method that determines the number of source particles to be started from specified volume elements. The systematic method is the only method that can be used for the special case of a single source tube. The energy of each source particle is chosen by a random method from an energy spectral distribution that is space independent. Provision is made in the program for splitting on region and energy to conform to the demands of the 18 series programs. Program 20-0 is coded for use on an IBM 704 having 32,768 magnetic core memory locations. Five magnetic tape units are used by the program. (auth)

15181 BUILD-UP FACTORS FOR HETEROGENEOUS SHIELDS. L. R. Kimel. Atomnaya Energ., 10: 173-5(Feb. 1961). (In Russian)

The build-up of Co^{60} γ-radiation dose factors in heterogeneous (two-layer) shielding was determined for a parallel-plane beam with normal incidence to the shielding, consisting of lead, iron, and aluminum plates (75 × 75 cm). The build-up factors were determined for combinations of Pb + Al, Al + Pb, Pb + Fe, Fe + Pb, Fe + Al, and Al + Fe, with the first material in the combination the closest to the irradiation source. (R.V.J.)

15182 MEASUREMENTS OF DOSE BUILD-UP FACTORS FOR RADIATION SHIELDING. Heinrich Georg Ebert (Institut fur Medizinische Physik und Biophysik, Göttingen, Ger.). Z. angew. Phys., 13: 95-9(Feb. 1961). (In German)

For the calculation of a shielding wall for radiation protection not only the attenuation factor μ but also the dose build-up factor are necessary because of the expansion of the wall and the resulting increase of the dose output. Three build-up factors with various capacity can be distinguished: (a) The dose build-up factor was calculated for a wall of arbitrary size. No universal validity can be claimed for this build-up factor; it is related only to a special measurement apparatus. (b) The dose build-up factor was calculated for an infinite expanding medium in which radiator and absorber are found (B^+). Values of this kind are published in the literature, but with an accuracy of only ±10 to 20%. (c) The dose build-up factor was calculated for a wall of infinite size. But this value B_∞ is significant for radiation shielding since through it the maximum dose output obtainable behind a shield can be calculated. A measurement method was investigated and described which permits the measurement of B_∞ with great accuracy (±5%) on relatively small absorber pieces. This measurement method is suitable for radiation shielding materials of high and average atomic numbers. The measurement results agree, in the range investigated, with the B^+ values given in the literature. For materials with low atomic numbers, deviations occur. Values for B_∞ are given for various materials and radiation qualities. (tr-auth)

15183 A MONTE CARLO CALCULATION OF GAMMA-RAY SCATTERING ON THE JEIDAC COMPUTER. T. Ishii (Univ. of Tokyo), T. Sekine, and K. Ono. p.53-66 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A computer-code calculating gamma-ray scattering was designed for the JEIDAC (HITAC 301 or NEAC 2203) computer. The code treats the problem of a gamma-ray penetrating into a lead wall through which a narrow slit runs. The shape of the slit cross-section may be chosen arbitrarily as a combination of line segments. The conventional weight method and the Klein-Nishina differential cross-section for the scattered photon in the Compton effect were used. The terminal condition of photon history is classified into three categories: escape; energy cut-off; and penetration through the wall. The monoenergetic point source is located at the center of the entrance of the slit. The initial direction of the photon was selected rather systematically, but uniformly into the space of the wall. Random digits were generated within the machine by the congruential method. Exponential random numbers ($f(x) = e^{-x}$) were prepared externally. The machine program consists mainly of the following parts: 1. Source, 2. Transport, 3. Geometry, 4. Collision, 5. Output, 6. Sub-Routines and others. The total number of instructions is about 1400 orders (700 words). Application to neutron problems can easily be made by changing the collision routine and the constants with brief considerations of the secondary gamma effect. The brief description of the HITAC 301 is as follows: 1960 twelve-digit words of magnetic drum memory; fully transistorized circuitry; paper tape input-output and auxiliary typewriter; one pair of single-address orders per word; two index registers for address modification; and an average multiplication time of 10 msec. The NEAC 2203 is quite similar to the HITAC except that it has three index registers, and floating decimal operation can be performed by the order code. (auth)

Theoretical Physics

15184 (AFOSR-224) DISSOCIATION CROSS SECTION. Siegfried Grossmann (Berlin. Freie Universitat. Institut fur Theoretische Physik). Nov. 1960. Contract AF61 (052)-217. 98p.

An investigation was made of inelastic scattering between hydrogen molecules and atoms. A derivation was made for a general spherically symmetrical statement for the two lowest potential-hypersurfaces of the H_3-problem. The quantum-mechanical, three-body scattering problem is discussed with respect to the boundary conditions. The scattering cross section, $\sigma_{0\to1}$, was investigated in the frame of the distorted waves approxi-

ation by various methods for the partial wave equation. he time-dependent intermolecular potential was found cause transitions, which are calculated by Dirac's erturbation theory. The transition matrix elements ithin the spectrum are discussed as well as the influence the virtual states of the molecule continuum on disso- ation. Discrete excitation processes are given in de- endence of energy, energy transfer, and excitation state the molecule as well as dissociation processes without ange of angular momentum in dependence of impact en- rgy and binding energy. (B.O.G.)

15185 (NP-9894) THE GELFAND-LEVITAN EQUATION FOR THE THREE-DIMENSIONAL SCATTERING ROBLEM. Technical Report No. 1. I. Kay and H. Moses Brooklyn. Polytechnic Inst.). Nov. 15, 1960. Contract onr-839(30). 25p.

A Gelfand-Levitan equation is introduced to calculate cattering potentials from part of the scattering amplitude n the three-dimensional scattering problem. The required art of the scattering amplitude is an analog of the reflection oefficient in one dimension. The obtained potential is ore general than that usually assumed in the three- imensional scattering problem in that it is diagonal in the adius variable but is a real integral operator in terms of he angular variables. The purely local potential, i.e., the otential which is diagonal in both the radial and angular ariables, appears as a special case. (auth)

15186 (TID-12165) THE TRANSITION MATRIX OR NUCLEON-NUCLEON SCATTERING. K. L. Kowalski nd D. Feldman (Brown Univ., Providence). [1960?]. 42p.

As part of a study of the influence of off-the-energy-hell effects on the optical potential for nucleon-nucleus cattering, a method is presented for the calculation, via he reactance matrix, of the nucleon-nucleon transition natrix in terms of an internucleon potential and the scat- ering amplitude. The singular integral equations for the artial-wave amplitudes of the reactance matrix are re- uced to a Fredholm form which contains the scattering mplitude parametrically. The iteration solution of the redholm equations is shown to be generally unreliable; owever, the zeroth-order iteration approximates the xact solution quite well near the energy-shell. The re- lacement of the kernels of the integral equations by eparable functions is discussed; the validity of such an pproximation is illustrated. The requirement that the olutions of the (exact) Fredholm equations be consistent ith the original singular integral equations yields a olution for the scattering amplitude in terms of the esolvent kernels of the Fredholm equations. The entire ormalism is so constructed as to include the possibility f a hard-core being present in the nucleon-nucleon inter- ction. (auth)

15187 (AEC-tr-4322) INTRODUCTION TO QUANTUM ELECTRODYNAMICS. A. A. Sokolov. Translated from a ublication of the State Publishing House of Physical-Mathematical Literature, Moscow, 1958. 576p.

Issued in two books.

The physical foundations and the computational methods f quantum electrodynamics are given. The successive tages in the development from a classical theory to the uantum electrodynamical theory are illustrated with ex- mples. The chapters treat the general theory of the free ield, interaction of electrons with second-quantized elec- romagnetic field, positron, and electron-positron vacuum. D.L.C.)

15188 THE ATOMIC MODEL OF THE PHOTRON THEORY. [PART II]. K. Nowak. Neue Physik, 2: Nos. 1/2, 1-41(1960). (In German)

Nuclear constituents are considered as photron configurations, explaining the fact that a nucleus can emit a particle which is not visibly contained and making possible a comprehension of nuclear force. Explanations of the origin of stationary motion within nuclear matter and the occurrence of conversion processes are given. The question of nuclear stability and the nucleon structure derived from scattering research are also discussed. Indications of erroneous calculated values of radiation energy are presented. (tr-auth)

15189 UNITARITY AND THE MANDELSTAM REPRESENTATION. R. W. Lardner (St. John's Coll., Cambridge, Eng.). Nuovo cimento (10), 19: 77-80(Jan. 1, 1961). (In English)

The three particle terms in the unitarity expansion for a scattering amplitude are examined on the assumption that the relevant production amplitudes satisfy single dispersion relations. It is shown that they can be made to satisfy the Mandelstam representation within the freedom which seems to be allowed by the unitary equation. The proof is extended to the four particle terms. (auth)

15190 ON THE DENSITY FIELD DESCRIPTION OF A BOSON SYSTEM. Hong-mo Chan and J. G. Valatin (Univ. of Birmingham, Eng.). Nuovo cimento (10), 19: 118-30 (Jan. 1, 1961). (In English)

The introduction of a density description through a field approach is discussed. Additional mathematical complications resulting from the appearance of powers of the δ-function can be avoided by means of a limiting process. The configuration space argument of Bogolubov and Zubarev is cast in an x-space form in which simple expressions are given. In the resulting representation the normalization integral is defined by means of a weight function the expression of which is determined. The weight function establishes the connection between the rather different expressions of the two density field representations. Some simple cases are considered and a variational principle is formulated. (auth)

15191 FIELD THEORIES WITH "SUPERCONDUCTOR" SOLUTIONS. J. Goldstone (C.E.R.N., Geneva). Nuovo cimento (10), 19: 154-64(Jan. 1, 1961). (In English)

The conditions for the existence of non-perturbative type "superconductor" solutions of field theories are examined. A non-covariant canonical transformation method is used to find such solutions for a theory of a fermion interacting with a pseudoscalar boson. A covariant renormalizable method using Feynman integrals is then given. A "superconductor" solution is found whenever in the normal perturbative-type solution the boson mass squared is negative and the coupling constants satisfy certain inequalities. The symmetry properties of such solutions are examined with the aid of a simple model of self-interacting boson fields. The solutions have lower symmetry than the Lagrangian, and contain mass zero bosons. (auth)

15192 ON A GAUGE THEORY OF ELEMENTARY INTERACTIONS. A. Salam (Imperial Coll. of Science and Tech., London) and J. C. Ward. Nuovo cimento (10), 19: 165-70(Jan. 1, 1961). (In English)

A theory of strong as well as weak interactions is proposed using the idea that all such interactions arise from generalized gauge transformations. (auth)

15193 INTERNAL CONVERSION FROM RESONANCE ABSORPTION. H. Frauenfelder, D. R. F. Cochran, D. E. Nagle, and R. D. Taylor (Los Alamos Scientific Lab., N. Mex.). Nuovo cimento (10), 19: 183-5(Jan. 1, 1961). (In English)

The Mössbauer re-emission spectrum in Fe^{57} is studied. A Co^{57} gamma source is mounted on a speaker, which is

driven at 11 cps. The re-emission of these rays is measured by a NaI scintillation crystal. Since internal conversion in Fe^{57} competes with gamma re-emission, a proportional counter is provided for measuring the 6.3 kev x-rays which are emitted by Fe^{57} following K-conversion. The spectra of gamma- and x-ray transmission are given as functions of relative source-absorber velocities. The use of this method in investigation of Mössbauer spectra of highly converted gamma rays is suggested. (T.F.H.)

15194 REMARK CONCERNING THE GRAVITATIONAL INTERACTION OF MATTER AND ANTI-MATTER. F. Winterberg (Case Inst. of Tech., Cleveland). Nuovo cimento (10), 19: 186(Jan. 1, 1961). (In English)

The proposal is made that the gravitational force between matter and anti-matter is of the same magnitude as that between matter and matter, but of opposite sign. It is shown, however, that this proposal leads to a violation of energy conservation. A cycle is considered in which energy is expended in production of a particle-antiparticle pair; the pair is transported to a different potential and annihilated; the photon returns to the original position. It is shown that an increase in energy occurs in this cycle, thus violating energy conservation. The same result is obtained if π-mesons are produced in the pair annihilation. (T.F.H.)

15195 ON THE AXIOMS OF QUANTUM FIELD THEORY. W. Weidlich (Freie Universität, Berlin). Nuovo cimento (10), 19: 277-91(Jan. 16, 1961). (In English)

A group of axioms for quantum field theory are discussed. This group varies in some respects from that of Lehmann, Symanzik, and Zimmermann, but it retains Lorentz-invariance, asymptotic conditions, and causality. The starting point in the development of these axioms is the non-relativistic canonical field theory, which is applied in a restricted sense to the relativistic case. As a consequence of the Theorem of Haag, the concept of local, causal fields must be generalized. (tr-auth)

15196 CONNECTION BETWEEN WIGHTMAN FUNCTIONS AND GREEN FUNCTIONS IN p-SPACE. D. Ruelle (Eidgenossische Technische Hochschule, Zürich). Nuovo cimento (10), 19: 356-76(Jan. 16, 1961). (In English)

A study is conducted of the analyticity properties of the Wightmann function $\underline{W}$, in the case in which time is the only complex variable. The Green function $\underline{G}$ has for its boundary value the Fourier transform of the mean value in vacuum of the product T of the field and the analytic continuation of the Lehman-Symanzik-Zimmermann retarding function in impulse space. A set of properties is established which characterize $\underline{G}$ such that if $\underline{G}$ possesses the given properties, there exists one and only one function $\underline{\tilde{W}}$ possessing normal properties and from which $\underline{G}$ is derived. (tr-auth)

15197 RENORMALIZATION IN A COMBINED LEE-MACHIDA FIELD THEORY. L. M. Scarfone (Rensselaer Polytechnic Inst., Troy, N. Y.). Nuovo cimento (10), 19: 377-81(Jan. 16, 1961). (In English)

It is shown that the energy of an observed V-ghost is sensitive to the renormalization procedure. (auth)

15198 SPIN IN CLASSICAL AND QUANTUM THEORY. H. C. Corben (Space Tech. Labs., Los Angeles). Phys. Rev., 121: 1833-9(Mar. 15, 1961).

The classical equations of motion of a charged point-particle with intrinsic spin under the influence of an external electromagnetic field are restated and compared with the Heisenberg equations of motion derived from the Dirac theory. The partition of angular momentum between particle and field in the classical theory is contrasted to the Dirac theory of electron spin. The analogy between the Dirac equation and the theory of parametric amplification is pointed out. A free spinning point particle moving according to the laws of classical relativistic point-particle mechanics may move along a helix. The sum of the intrinsic spin σ and the angular momentum of the helical motion in this classical analog of zitterbewegung is an effective spin vector S which is a constant of the motion. Because of this internal motion, the effective mass M of the particle differs from the mass m which is ascribed to it in the equations of motion. Solutions are found in which S is parallel or anti-parallel to the momentum, and the sign of M is determined by the helicity. When placed in a uniform electromagnetic field, the particle behaves as if it had a rest mass M and a magnetic moment $e\sigma/Mc$, in addition to any explicit magnetic moment that may be ascribed to it. (auth)

15199 RELATIVISTIC MODEL FIELD THEORY WITH FINITE SELF-MASSES. F. Zachariasen (California Inst. of Tech., Pasadena). Phys. Rev., 121: 1851-62(Mar. 15, 19

A model field theory is invented in the following way: Dispersion relations in the energy are assumed to hold for all amplitudes. Unitarity gives the absorptive parts in the "physical" regions. If it is assumed that the absorptive parts are otherwise zero (in violation of crossing symmetry and the Mandelstam representation), then the dispersion relations and unitarity form an infinite set of coupled integral equations for all amplitudes. An exact solution (at least for the simplest amplitudes) to this set of equations can be found, in which all self-masses, etc., are finite. The solution is equivalent to summing a certain class of Feynman graphs, computed in the usual way. For a wide range of coupling constants, there are no "ghost" difficulties. (auth)

15200 ON THE DENSITY MATRICES USED IN HARTREE-FOCK CALCULATIONS. D. Ter Haar (Clarendon Lab., Oxford). Physica, 26: 1041-4(Dec. 1960). (In English)

It is pointed out that the density matrices ρ_{HF} used by quantum chemists and others in the discussion of the Hartree-Fock self-consistent field method differ from the density matrices ρ_{SM} introduced in statistical physics and that the idempotency condition for ρ_{HF} has therefore a physical meaning which is different from the same condition for ρ_{SM}. A suggestion is made for a consistent nomenclature. (auth)

15201 METASTABLE STATES IN STRONGLY COUPLED QUANTUM SYSTEMS WITH CONTINUOUS SPECTRA. Lewis H. Nosanow (Rijksuniversiteit, Utrecht). Physica, 26: 1124-42(Dec. 1960). (In English)

The problem of constructing metastable states in strongly coupled quantum systems whose spectra are continuous is treated within the context of the general perturbation method developed by Van Hove. The state is constructed in terms of the unperturbed states and its metastable character is proved without explicitly introducing the perturbed stationary states. An interesting feature of the result is that the construction of the state requires the use of a complex number, the real part of which is equal to the energy of the state, whereas its imaginary part is much larger than the line width of the state. The general result is applied to the Fermi gas and the Lee model. (auth)

15202 SUMMER INSTITUTE IN THEORETICAL PHYSICS, LECTURE NOTES, BRANDEIS UNIVERSITY, 1959. F. E. Low, J. Schwinger, E. C. G. Sudarshan, L. H. Cooper, K. Huang, H. J. Lipkin (Notes by W. A. Mills, A. M. Kaufman, J. D. Childress, Z. Fried, K. Huang, and M. Turoff). Waltham, Mass., Brandeis University, 1960. 451p.

Papers that are compiled from lecture notes taken at

he Brandeis University 1959 Summer Institute in Theoretical Physics are given. Separate abstracts have been prepared for each of the papers. (T.F.H.)

15203 THE QUANTUM THEORY OF SCATTERING. F. E. Low. Based on a Course of Lectures Given at the Brandeis University Summer Institute in Theoretical Physics, 1959. Wayne A. Mills, comp. p.79 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

Non-relativistic scattering by nuclear forces is considered for zero-spin systems. Discussions of cross sections and effective ranges are presented, given the assumption of simplifying initial conditions. The scattering-matrix S-matrix is studied as a method for generalization of scattering problems. Conservation of energy and momentum are investigated; symmetry properties, such as invariance under rotation, Lorenty invariance, reflection invariance (parity), and time-reversal invariance are also analyzed. The scattering optical theorem and S-matrix unitarity are presented. General examples of scattering theory are discussed, including bremsstrahlung, reactions of the type $(n + d \rightarrow n + n + p)$, and the impulse approximation concept. (T.F.H.)

15204 FIELD THEORETIC METHODS. A Course Given by Julian Schwinger at Brandeis University in the Summer of 1959. Notes by A. Kaufman. p.81-207 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

The quantum field theory is investigated; it is shown that the unity of the theory for low and high energy phenomena follows from a fundamental principle of action. Major aspects of quantum field theory, such as existence of commutative (Bose-Einstein) and anticommutative (Fermi-Dirac) fields, the TCP theorem and covariant formalism, and properties of field equations, are studied in detail. The electromagnetic field is discussed in terms of an indefinite metric. Green's functions are employed in calculations of physical states and time developments of systems, as functions of the systems' interactions with external systems. (T.F.H.)

15205 WEAK INTERACTIONS. Notes Based on a Course of Lectures by E. C. G. Sudarshan, University of Rochester at the Summer Institute in Theoretical Physics, Brandeis University, 1959. J. D. Childress, comp. p.209-58 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

A discussion of elementary particles is presented. Invariance and symmetry properties, and conditions for the validity of these properties, are considered. Interactions are classified as weak, strong, and electromagnetic; the theory of weak interactions is pursued. μ meson decay, β decay, and the two-component-neutrino hypothesis are discussed, as well as other types of weak interactions. Chirality invariance, vector current conservation, and the universal four-fermion interaction are considered. (T.F.H.)

15206 THEORY OF SUPERCONDUCTIVITY. Lectures given by Professor L. N. Cooper, Brown University, Providence, Rhode Island. Transcribed by Z. Fried. p.259-91 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

Superconductivity is studied by making simplifying assumptions about metals, in order to obtain solutions for the Schrödinger wave equation for $\sim 10^{23}$ particles. Maxwell's equations for zero resistivity are shown to yield results compatible with empirical observations. The electron theory of metals, including the electron lattice vibration interaction, is reviewed. Normal metals are described as having independent electrons in atomic lattices, while in superconductors, a theory is described (Bardeen-Cooper-Schrieffer) in which two-particle correlations are important. Using this theory of superconductors, the ground-state wave function of a superconductor is derived by means of statistical mechanics. Several properties of superconductors are described. (T.F.H.)

15207 LECTURES ON HARD-SPHERE BOSE GAS AND LIQUID HELIUM. Kerson Huang (Massachusetts Inst. of Tech., Cambridge). p.293-406 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

A system of interacting spin-zero particles is considered. The system is described quantum-mechanically, and its wave functions are derived. It is shown that a quantized field may be derived from an n-particle system, and vice versa. In the case in which the system is a hard-sphere Bose gas, methods of quantum mechanics and statistical mechanics are outlined for handling the system's properties and interactions. The kinetic theory is applied to ground-and near-ground-states in an attempt to explain low-temperature superfluidity and hydrodynamics. The results of these investigations are applied to the empirical and theoretical properties of helium near 0°K. (T.F.H.)

15208 COLLECTIVE MOTION IN MANY-PARTICLE SYSTEMS. Harry J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel). Lecture Notes of a Course Given by Professor Lipkin at the Summer Institute in Theoretical Physics, Brandeis University, Summer, 1959. Notes taken by Murray Turoff. p.407-54 of "Summer Institute in Theoretical Physics, Lecture Notes, 1959." Waltham, Mass., Brandeis University, 1960.

The n-body problem is solved for $n = 2$. The nuclear shell model is studied, in which forces saturate; plasma oscillations in electron gases are also considered, in which the long range Coulomb forces are screened by electrons. In both of these examples, independent-particle wave functions cannot be used; methods are proposed for finding valid solutions for the fields. Collective and independent-particle models of nuclei are compared and a generalized method is derived for treating collective variables. The strong coupling meson theory is also derived. (T.F.H.)

REACTOR TECHNOLOGY

General and Miscellaneous

15209 (ANL-6328) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, FEBRUARY 1961. (Argonne National Lab., Ill.). Mar. 15, 1961. Contract W-31-109-eng-38. 80p.

Design, development, and testing efforts were continued on BORAX-V, EBR-I, EBR-II, EBWR, JUGGERNAUT ZPR-III, ZPR-VI, and ZPR-IX. An evaluation program is outlined for Pebble Bed Reactor designs. Fast and thermal reactor safety studies were conducted. Experimental and theoretical studies in applied nuclear and reactor physics are described. Developments made in reactor components, fuels, and materials are discussed. Heat engineering studies were conducted on steam separation, and velocity and void distributions in two-phase systems. Fluidization and fluoride volatility separation, and chemical-metallurgical separation processes were studied. Advanced reactor concepts that were discussed included: Basic Radiation Effects Reactor, Biogeonuclear Reactor, Fast Reactor Test Facility, compact high-power density fast reactors, AHFR hydraulic test loop, Packed Bed Reactor, and direct conversion. (For preceding period see ANL-6328.) (B.O.G.)

15210 (APAE-57) DUPONT PROTOTYPE SAFETY AND CONTROL ROD DRIVE TESTING. G. M. VandeMark and P. S. Krause (Alco Products, Inc., Schenectady, N. Y.). Apr. 25, 1960. Contract AT(07-2)-1. 66p. For Du Pont de Nemours (E. I.). & Co. Subcontract AXC 24464-1/2.

Prototype testing of the safety and control rod drives at a pressure of 1500 psi and at room temperature and 550°F indicated that both units functioned properly. No major problems were encountered during testing. Seal leakage data indicated that the seal units were performing satisfactorily. Scram times during both cold and hot testing were excellent. Testing procedures used are given. (auth)

15211 (CISE-84) THE FIXED BED FUEL ELEMENT. G. Perona (Centro Informazioni Studi Esperienze, Milan). Jan. 1961. 10p.

A fuel element is described which consists of small spheres of UO_2 filling the space between two concentric perforated metal tubes. The perforations are smaller in diameter than the pellets, and allow water to circulate over the pellets from the outside tube to the inside tube, thus acting as a coolant-moderator for the fuel element. Calculations are given in which the advantages of using spherical fuel shapes can be seen. A feature which led to further considerations of a fixed bed reactor was the possibility of producing and superheating steam in the same fuel element. (B.O.G.)

15212 (DP-557) SAMARIUM TABLES. Julius C. English (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.) and T. C. Gorrell (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Feb. 1961. Contract AT(07-2)-1. 34p.

Tables are presented that may be used to estimate the reactivity transients resulting from samarium poisoning in any thermal reactor that employs U^{235} as the principal fissionable material. The Sm^{149} concentration is given as a function of time in units of samarium absorptions per fission neutron. For enriched reactors, these units approximate closely the reactivity held in samarium. The thermal flux is expressed in units of megawatts from thermal fissions per kg of U^{235}. Table entries are spaced at flux increments of 0.2 in the range from 0.0 to 10.0. (auth)

15213 (INTERNUC-60) UTILIZATION OF THE WCAP-4 IN PILE TEST LOOP FOR PRESSURIZED WATER REACTOR RESEARCH AND DEVELOPMENT. W. A. Greaney and O. J. Elgert (Internuclear Co., Inc., Clayton, Mo.). Aug. 1, 1960. 51p.

The WCAP-4 in-pile test loop is evaluated regarding its possible utilization for pressurized water reactor (PWR) research and development. It is concluded that, by installing the test loop in available reflector positions of the Engineering Test Reactor (ETR) and by redesigning the in-pile tube, the loop can be used for developing soluble or burnable control materials or for testing fuel elements. In its present location it is considered to be a suitable facility for coolant technology studies in which the need to duplicate PWR radiation environments is not critical. (auth)

15214 (MND-C-2204) ANPP CODE DEVELOPMENT PROGRAM, PRESSURIZED WATER TASK. Quarterly Progress Report Number Five. T. M. Olsen, L. Welshans, and C. Eicheldinger (Martin Co. Nuclear Div., Baltimore). Nov. 1960. Contract AT(30-1)-2431. 201p.

Checkout of the SN option of SYNFAR was completed except for some minor additions to the program. CELCOR was checked out for all geometries using P1 fluxes and for all one-dimensional geometries using SN fluxes. A spectral hardening correction was added to SYNFAR and checked out. Instabilities discovered in the dynamic option of SYNFAR were corrected. The Blackness Coefficient Code was assembled and checked out. Control rod worth of the PMZ-1 Core 52 six-rod bank was calculated, using blackness theory. The calculated rod bank worth of 19.42% compares favorably with the experimentally measured value of 19.06%. Specifications for SYBURN were completed and coding was started on the fission product poisoning option. The CURE-TDC comparison indicated that 50% more mesh points were necessary for CURE than for TDC to obtain a K-eff within 1% of the asymptotic value for the 127-tube PMZ-1 just-critical core. For this accuracy, TDC runs about 20% longer than CURE. The CURE and TDC asymptotic values for K-eff differ by about 7%. XFIT, a reassembled version of the Westinghouse exponential curve-fitting code F0031, was checked out and used to process all the results available from the pulsed neutron experiments. A revised Temperature Coefficient Code, TCRP, was assembled and checked out. Experimental data may now be processed in one machine run rather than the two formerly necessary. Subroutine RWTSET, for consolidating the read and write binary tape subroutines of SYNFAR and CELCOR, was coded using FORTRAN FAP and checked out. The subroutine reduces the length of SYNFAR by 700 decimal locations, thus providing additional storage for theory. 38 materials were analyzed and written on the basic library cross section tape. Inelastic scattering matrices were produced for 38 materials. A FORTRAN program was written to permit the copying and/or updating of the tape containing the inelastic scattering matrices. A

-level cross-section tape for 38 elements and 3 combinations (OY, SS304, and H_2O) was written. A FORTRAN program was assembled and checked out which uses the 26-vel tape and punches out cards in the format necessary r updating or writing a new NDT tape. Four materials H_2O, SS304, OY, and B) were updated, the changes including the effects of inelastic scattering through a change in Σ_s terms. The resonance absorption integral of SS304 as calculated to be 1.65 barns, as compared with the xperimentally measured value of 2.22 barns. Critical xperiments were performed on Cores 400, 403, and 350. omplete experimental programs were performed on Cores 00 and 403. The work on Core 350 consisted of a redetermination of the critical mass and buckling using three rather then two) plastic spacers. Pertinent data on the ores studied are presented. Homogeneous fuel elements ere fabricated and assembled for Cores 402, 403, and 04. Core 350 was analyzed using the dynamic, spectral ardening, and average buckling between interface options f SYNFAR. The results, for the most part, compared avorably with the experiment. A prompt neutron lifetime f 29μ sec was computed as a function of the experimental alue of 25μ sec. Core 450 fine flux and activation distributions were analyzed using the 1D-P1 and SN options of YNFAR. Both the P1 and SN options gave flux plots quite bit flatter than the experimental activation plot. (For receding period see MND-C-2203.) (auth)

5215 (MND-P-3010) SNAP PROGRAMS, TASKS 2, 3, AND 6; QUARTERLY PROGRESS REPORT No. 2, JANUARY TO MARCH 31, 1960. (Martin Co. Nuclear Div., Baltimore). Dec. 1960. 331p.

System Design. A chem-milled outer skin, an improved thermoelectric element adjustment and access plug, a flexible stainless steel-aluminum joint welded via ultrasonic techniques, a flexible hot shoe assembly, and thermal hydraulic heat dump system were incorporated into the design of the environmental and ground test generators. Materials Analysis. Burnup studies on fuel forms were continued with CeF_3 and CeO_2. SiC_2 appeared to be the most promising addition to CeO_2. Tests showed that the Alleghany Ludlum alloy S-818 alloy is resistant to attack by CeO_2 and CeF_3, but is attacked by Ce metal. Hazards Analysis. Analyses of launch abort impact zones for the open core and of aerodynamic burnup for near orbital injection on two types of Mo fuel cores continued. Manufacturing. Fabrication and assembly of the first electrically heated generator was completed. System and Component Test. It was found that lead telluride couples increased in resistivity after heating to 1000°F and masked resistivity changes because of radiation. Inconel X cores were heated to approximately 1500°F and impacted on either granite or water targets. All of the cerium-metal loaded cores ruptured. Cores loaded with lavite pellets were recovered intact. Heat transfer mockup tests were completed with a revised two-layer stainless steel heat shield. SNAP-III. The 3M1G3 thermoelectric generator was repaired and parametric testing resumed. The power output of the second SNAP-III unit was measured and proof of thermoelectric generator operation for at least a period of a year was demonstrated. SNAP-IIIA. The performance characteristics of a second SNAP-IIIA generator of completely new design were only marginally better than the original. Tests were performed on metal-encased and ribbon-emitter types of tubes. A wire-wound ceramic heater and a tungsten-wire radiation heater were fabricated and tested. Work was continued on the molybdenum collector used in conjunction with a Type B impregnated tungsten emitter. Low Power Thermionic Generator. Work on improved heat transfer between the emitter holder and the heat source revealed that a layer of Mo powder between the two surfaces gives a lower film drop and more consistent results. Creep tests on sapphire spacers (Al_2O_3) showed that some creep takes place above 1200°C, and above 1300°C, the strength of the sapphire falls off rapidly. A device for measuring the thermal expansion of CeO_2 fuel pellets while in a hot cell was fabricated. Thermoelectric 2- to 5-Watt Generator. Altitude chamber tests of the generators were successfully completed. A shock-wave test proved the capsule can survive missile propellant detonation. Power output versus time plots were developed for both the cerium- and polonium-fueled systems. (M.C.G.)

15216 (NYO-9063) FUEL ELEMENT DEVELOPMENT PROGRAM FOR THE PEBBLE BED REACTOR. Quarterly Progress Report, November 1, 1960 to January 31, 1961. (Sanderson and Porter, New York). Contract AT(30-1)-2378. 28p.

Pyrolytic Carbon Coated UC_2 Particles. Two types of commercially prepared pyrolytic carbon coated UC_2 particles were evaluated. They are identified as Batch PyC-7 and Batch PyC-8. The Batch PyC-8 particles were seen to have bumpy surfaces. Metallographic examination under polarized light showed a conical carbon growth structure typical of coatings deposited at about 3600°F. The Batch PyC-7 particles were seen to be smooth and the conical growth structure was not evident under polarized light indicating a coating deposited below 2900°F. Alpha assays of the particles showed surface uranium contaminations of 10^{-5} to 10^{-4} of the uranium contained in each particle. The values are somewhat higher than the typical values found for Al_2O_3 coated UO_2. Acid leaching indicated that in some cases the uranium contamination was within the coating surface and could not be reduced by leaching. In other cases, the leach test indicated that a number of faulty particles were present since a large increase was noted in uranium contamination after leaching because of uranium in solution being deposited back on the coating surfaces. Fueled Spheres. A graphite sphere fueled with PyC/UC_2 particles (Type FA-25) was examined. The coated particles were uniformly dispersed throughout the FA-25 spheres. There was no evidence of coated particle damage in the region where the molding flash was removed. The FA-25 spheres were designed to have a subsequent protective coating of siliconized silicon carbide. A neutron activation test of one specimen showed a Xe-133 release fraction of 1.1×10^{-3} on heating for 3 hr at 1650, 2100, and 2400°F. Similar data on spheres fueled with Al_2O_3 coated UO_2 showed Xe-133 release fractions of about 10^{-6} in a 4 hr heating period. Subsequent evaluation of the FA-25 specimens produced no clear evidence that the PyC/UC_2 particles were damaged in fabrication and appeared to indicate that there were faulty particle coatings prior to sphere fabrication. Al_2O_3 Coated UO_2. A commercially prepared Al_2O_3 coated UO_2 was examined. The coating was applied by the vapor deposition technique at 1830°F. A rotating kiln was used in coating the particles rather than a fluidized bed as in previous Al_2O_3/UO_2 work. The 105- to 149-micron UO_2 shot was coated with 40 microns of Al_2O_3 in eight steps. A 5-gm sample experienced only a 0.0024-gm weight gain after a 5-hr exposure to 1200°F air. There was no detectable surface uranium contamination on the as-received particles using the alpha assay technique. The total exposed uranium, i.e. residual surface contamination plus uranium in solution, after leaching in hot nitric acid was 10^{-5} of the contained uranium. In-Pile Loop. The installation of an In-Pile Loop

in the Brookhaven Graphite Reactor was completed. The Loop was designed to study the behavior of fission products released from a PBR fuel element into a recycled helium stream. Irradiation was started using an unfueled electrically heated, graphite sphere in place of a fueled specimen to complete shakedown testing prior to fueled-sphere operation. Operations were curtailed when it was discovered that a leak had developed in the vacuum insulation annulus of the in-pile section which appeared to have occurred during the exceptionally difficult insertion prior to start up. The effect of the leak was to limit operating temperatures to about 500°F gas outlet and 800°F in the specimen, instead of the design values of 1250°F and 1800°F. The leak could not be repaired because the in-pile section was too highly activated. Consequently, a new in-pile section was fabricated and, concurrently, a graphite sphere fueled with Al_2O_3 coated UO_2 was irradiated in the defective in-pile section. The R/B, i.e. release rate/product rate, values from this specimen for the longer lived fission-product gases were found to range from 3×10^{-7} to 1×10^{-6}, at about 900°F specimen temperature, with very little dependency on isotope half-life. The data are consistent with previous capsule irradiation data on "low release" fuel elements. After the new in-pile section was fabricated, it was installed in the BNL Reactor together with a "high release" graphite sphere fueled with uncoated UO_2 shot. During operation with this specimen, it became apparent that in addition to the expected increase in gamma activity in the Loop, a significant neutron flux was appearing in the out-of-pile section of the Loop. Attempts to reduce the delayed neutron flux by installing a special parraffin-cadmium-lead shield on top of the loop were not entirely successful. Because of this interference with adjacent experiments, further operation was ruled out with this specimen. Prior to concluding operations, samples of the recirculating helium stream were taken to permit analysis for both the longer-lived fission products and the non-volatile daughter products of the shorter-lived fission products. During operation, the gamma activity levels were 1.5 r/hr at the pipe coming from the in-pile section and 7 r/hr at the primary flowmeter located at the most distant point from the in-pile section. The high reading at the flowmeter is believed to be due to a fission product accumulation at a damping orifice located at the flowmeter outlet. 21 hr after shutdown, the activity levels had decreased to 180 mr/hr at the outlet pipe and 2 r/hr at the flowmeter. A complete scan of the out-of-pile section after shutdown revealed a definite decrease in deposited activity as a function of distance from the in-pile section. (auth)

15217 (PAN-184/IX) THE DISTRIBUTION OF NEUTRON SPECTRUM TEMPERATURES IN AN INFINITE PLATE OF A HEAVY GAS MODERATOR. Z. Weiss (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Oct. 1960. 18p.

The problem of slowing down of thermal neutrons was solved in an infinite plate of heavy gas moderator of temperature, T. Because the spatial and energy variables were not separated, a properly defined neutron spectrum temperature distribution was obtained in diffusion approximation. The thermalization constant for graphite moderator was calculated as a function of the plate thickness, a. It was shown that the thermalization constant depends essentially on the plate thickness. In the limit, for $a \to \infty$, the value of thermalization constant was obtained in agreement with earlier results. (auth)

15218 (TID-12192) ETR IN-PILE LOOP STRESS ANALYSIS. J. E. Minkle (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 15, 1958. 30p. (TIM-557)

The analysis revealed that the stresses and strains were within the design limits, based on criteria for pressure loading and thermal gradients. The method of analysis is described. Design conditions and calculated stresses and strains throughout the assembly are tabulated for the motor and pump, heat exchanger, test element, and water jacket sections. Because of the low stresses in the hanger and installation section, these values are not tabulated. (B.O.G.)

15219 PROGRESS IN THE DEVELOPMENT OF THE SODIUM GRAPHITE REACTOR. R W. Dickinson and H. Polak (Atomics International, Canoga Park, Calif.). Atomkernenergie 6: 9-15(Jan. 1961). (In German)

The experience gained from the Sodium Graphite Reactor program, initiated at Atomics International in 1949, is based on construction and operation of the Sodium Reactor Experiment, the design of the Hallam Nuclear Power Facility presently under construction, and an extensive research and development program well under way covering all aspects of sodium graphite reactor technology. Based on the results obtained from our technical programs, various design studies and economic calculations have been made for large sodium graphite reactor plants of present and of forecast 1962 technology. These studies have shown that the inherent characteristics of this concept make it attractive from a technical as well as an economic standpoint and warrant its competitiveness with fossil fired power plants at an early date. (auth)

15220 THE DETERMINATION OF THE TRANSFER FUNCTION OF A NUCLEAR REACTOR BY MEANS OF STATISTICAL METHODS. G. Schweizer (Argonne National Lab., Ill.). Atomkernenergie, 6: 18-25(Jan. 1961). (In German)

It is known that the ordinary methods of determining the transfer function of an object by measuring the reaction to an artificial sinusoidal input are inapplicable in many cases. Often it is not possible to apply a sinusoidal stimuli, because this leads to a disruption of the process, or very frequently random uncontrolled signals are superimposed at the output. In view of this circumstance great emphasis has been laid recently on transfer function measurements with statistical methods, especially for the dynamic behavior of nuclear reactors. The difficulties involved in the experimental techniques are rather complex. Digital and analog methods are described for determining the transfer function of a linear system. It was not possible to derive all the mathematical relations for the inevitable statistical errors. However, some emphasis has been made in order to develop simple methods and graphs for the practical determination of the errors involved in the measurement. The transfer function of the Argonaut reactor was measured using different methods, and the experimental results are shown. (auth)

15221 SIMPLIFIED TWO-GROUP CALCULATION FOR GRAPHITE-MODERATED REACTORS. H. Benzler and H. Nyland (Deutsche Babcock & Wilcox-Dampfkesselwerke AG., Oberhausen/Rheinland, Ger.). Atomkernenergie, 6: 49-58(Feb. 1961). (In German)

In the case of the graphite-moderated slightly enriched nuclear reactor the normal lengthy two-group calculation can be effectively reduced by some simple approximations. It is possible to find the neutron distribution by means of some very short slide rule calculations. (auth)

15222 A METHOD FOR THE CALCULATION OF THE CRITICAL FEEDING LIMIT IN POSITION VARYING BUCKLING. O. Machnig and W. Giesser (A. G. BBC-Krupp,

annheim, Ger.). Atomkernenergie, 6: 58-62(Feb. 1961). n German)

It is assumed that the material buckling in a homogeneous linder reactor without reflector is dependent on the loca- on in one dimension, perhaps through continuous feeding. simple approximation procedure is described which per- its, starting from a medium buckling, a satisfactory esti- ate of the critical feeding limit quickly to be obtained. lso, information is obtained on the corresponding neutron stribution. A numerical example is calculated. (auth)

5223 THE THERMAL STRESSES IN THE WALLS OF REACTOR HAVING INTERNAL HEAT SOURCES THAT ARY IN OUTPUT. B. I. Maksimenko, K. N. Nikitin, and . I. Bashkirov. Atomnaya Energ., 10: 131-7(Feb. 1961). n Russian)

The thermal stresses in the assembly and auxiliaries perating at varying heat loads may exceed the thermal tresses at established stationary conditions. Hence, in rder to secure safe operations of the assembly and auxil- aries at variable loads, the rate of these processes should e limited and the geometry of the assembly reduced to ane or cylindrical walls. A comparative analysis of ther- oelastic stresses in the walls at variable loads is made on ie basis of the solution for thermal conductivity problem r plane and cylindrical reactor walls having an internal eat source. (tr-auth)

5224 MEASUREMENT OF REACTOR PARAMETERS. PART] II. Lajos Bata (Central Physics Research Inst.). nergia és Atomtech., 14: 32-9(Jan. 1961). (In Hungarian)

Calculation of the thermal utilization factor is relatively imple in the case of homogeneous systems because the ross section is not dependent on the location as the number f fissionable and moderating nuclei remains constant roughout the core. In heterogeneous systems the average ux must be calculated or measured in various points of the uel and of the moderator; both integral and differential ethods of flux distribution measurement may be used. -235 foils were successfully used as detectors. While ie thermal utilization may be estimated with good approxi- ation on the basis of a differential method, it is not quite cceptable for determining the flux distribution. The diffu- ion equation must be corrected for the following reasons: ransient phenomena may occur at the fuel–moderator nterface; the fission neutrons are not completely thermal nd monoenergetic; the neutron temperature may exceed ie moderator temperature. The flux distribution of the ubcritical assembly SR-1 formed by the fuel elements of he VVRSz reactor was determined using Rh foils. (TTT)

5225 A PROPOSED WATER COOLED REACTORS DECONTAMINATION SYSTEM. A. M. Potestà (FIAT, urin) and R. M. Watkins. Energia nucleare (Milan), 8: 9-104(Feb. 1961). (In English)

A decontamination system for water cooled reactors is roposed. The system is designed to be used prior to main- enance operations in the primary system. The decontami- ation procedure involves the oxidation of the corrosion roduct film by an alkaline permanganate solution followed y the removal of the oxidated film by an ammonium cit- ate solution. (auth)

15226 PRESENT TRENDS IN NUCLEAR FUELS. C. Bella (CAMEN, Leghorn). Energia nucleare (Milan), 8: 135-48(Feb. 1961). (In Italian)

Nuclear fuel elements are considered which are able to withstand temperatures much higher than those currently reached in reactors. Uranium alloys offer possibilities for increased reactor temperatures. However in order for nuclear kwh to become competitive with power from conventional sources (operating temperatures of 800 to 1500°C are necessary), the most satisfactory prospects are to be found in fuel elements constituted of fissionable ceramic compounds. After reviewing the disadvantages which are common to metallic fuels in general, the possibilities for applications of ceramic fuels are evaluated. The utilization of these compounds as matrices for dispersion fuels is examined. (auth)

15227 CRITERIA FOR THE ESTIMATION OF REACTOR SAFETY. Th. Schaub (Institut fur Reaktorforschung, Würenlingen, Switzerland). Neue Tech., 2: No. 12, 24-33 (Dec. 1960). (In German)

A scheme of the influences on which reactor safety depends is developed and some of the main contributing factors described more closely. Using investigations from non-nuclear fields the order of magnitude of failure probabilities and their influencibility is shown and comparisons made with the reactor field. (auth)

15228 ON THE DESIGN AND MANAGEMENT OF FAST REACTOR BLANKETS. S. A. Hasnain and D. Okrent (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 314-22(Mar. 1961).

The performance of some blanket designs is studied using economically optimized cycling based on a simple economics model. For an 800-liter core fast reactor having a 45-cm radial blanket and an average core power of 1-Mw per liter, it appears that the outermost blanket elements make enough plutonium to pay for the cost of their fabrication and processing, unless the core power density falls well below the expected value. A cyclic motion of elements in the inward radial direction has little effect on the economics if optimum cycling is followed. Moving the blanket elements may have engineering advantages however, such as a uniform buildup and burnup, and less variation in power locally with time. A paste blanket with radial inward motion and axial mixing has a similar behavior. Inclusion of moderating material in a fast reactor blanket is not promising for a high-power density reactor using optimum cycling, but it may prove valuable if blanket fluxes get very low or the residence times of the blanket elements are limited. (auth)

15229 EFFECT OF SPECIFIC POWER ON FUEL REACTIVITY AND COSTS IN THORIUM-FUELED REACTORS. E. A. Mason and J. A. Larrimore (Massachusetts Inst. of Tech., Cambridge). Nuclear Sci. and Eng., 9: 332-40(Mar. 1961).

In reactors fueled with thorium, increasing specific power leads to reduction of fuel reactivity lifetime and conversion ratio because of the appreciable decay time and neutron absorption cross section of Pa^{233}. A generalized study of these effects in thorium–U^{233} fueled reactors is carried out using a simplified reactor model. The most important specific power effect on fuel reactivity is the holdup of Pa^{233}, rather than its burnout to U^{234}. Using conventional cost bases, the effect of specific power on the fuel costs for thorium fueled reactors is shown to be small in the range of practical specific powers. (auth)

15230 THE PROPERTY OF FINALITY AND THE ANALYSIS OF PROBLEMS IN REACTOR SPACE-TIME KINETICS BY VARIOUS MODAL EXPANSIONS. S. Kaplan (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 9: 357-61(Mar. 1961).

In the analysis of a reactor space-time problem by the method of modal expansion, the labor is reduced and accuracy improved if the modes are chosen such that the expansion has the property of finality. Modes having this prop-

erty are identified for a zero power (no feedback) reactor and for a reactor with linearized xenon feedback. (auth)

15231 THE SOLUTION OF THE REACTOR KINETICS EQUATIONS FOR LARGE AND SMALL EXCURSIONS. J. C. Carter and Nye F. Morehouse, Jr. (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 362-6(Mar. 1961).

The study of reactor control systems for large excursions has presented considerable difficulty on both analog and digital computers. Two simple transformations are derived which permit an accurate solution of such systems over many decades on an analog computer. (auth)

15232 NEW ANALYTICAL FORMULA FOR DANCOFF CORRECTION FOR CYLINDRICAL FUEL LATTICES. Yuzo Fukai (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng., 9: 370-6(Mar. 1961). (HW-5026)

The Dancoff correction has an important role in the calculation of the resonance escape probability of water moderated lattices. By use of the method of Dancoff and Ginsburg, it is shown how to take account of the shadowing of distant neighbors by near neighbors. Although these results are in good agreement with Monte Carlo calculations, the method is very complicated and laborious. A new approximate analytical formula for the Dancoff correction is developed which is much simpler and which gives good agreement with the Monte Carlo results. (auth)

15233 THE REDUCTION OF THE TIME-DEPENDENT EQUATIONS FOR NUCLEAR REACTORS TO A SET OF ORDINARY DIFFERENTIAL EQUATIONS. J. Lewins (25 Corps Engineer Regiment, Osnabrück, Ger.). Nuclear Sci. and Eng., 9: 399-407(Mar. 1961).

The average or over-all behavior of a reactor is expressed through a weighting function that corresponds to the detectors used to observe the behavior. The special properties are considered of three particular weighting functions; static, dynamic, and perturbation. The functions are compared on two grounds: first for the rigor in the reduction to the well-known equations describing reactor kinetics in the ordinary differential form, and second for the degree to which they permit approximations to the density without prejudicing the agreement between calculation and observation. The investigation considers particularly the effect of fuel mobility and the complications of the nonseparable, nonlinear problems, with a generality that is independent of any particular physical model. (auth)

15234 RE: "AN H_2O-D_2O MODERATED REACTOR." Paul F. Zweifel (Univ. of Michigan, Ann Arbor) and John J. Happell (Babcock and Wilcox Co., Lynchburg, Va.). Nuclear Sci. and Eng., 9: 412-13(Mar. 1961).

A discussion arising from previous reports; Bebbington, Nuclear Sci. and Eng., 8: 720 and Klug, Nuclear Sci. and Eng., 7: 591(1960); is presented. It is shown that so long as reconcentration requirements for a variable H_2O-D_2O moderator reactor do not encompass either the low concentration range (0.015 to 1% D_2O) or high concentration range (99 to 99.99% D_2O), neither capital nor operating costs for an associated reconcentration plant will be prohibitive. (N.W.R.)

15235 ESTIMATION OF THE NEUTRON HEATING IN Be CANNING. Albert Müller (Siemens-Schuckertwerke A. G., Erlangen, Ger.). Nukleonik, 2: 277(Dec. 1960). (In German)

In thermal reactors with uranium fuel elements in Be cans, it was experimentally established that the fuel temperature coefficient of reactivity can become positive with increased burn-up, whereas with Zr cans it remains negative. The origin of this effect must lie in the thermal spectrum of the neutrons absorbed in the fuel elements. Therefore the coefficient $(1/\eta) \times (\partial\eta/\partial T_B)$ where T_B is the fuel temperature) was evaluated for a 19-rod fuel element of UO_2 with Be canning and Be conduit pipes and with CO_2 as coolant. Similar calculations were made for Zr canning. (J.S.

15236 PULSED NEUTRON SYSTEM FOR REACTOR MEASUREMENTS. R. D. Kelly (Univ. of New Mexico, Albuquerque). J. C. Hamilton and L. C. Beavis. Rev. Sci. Instr., 32: 178-83(Feb. 1961).

A complete pulsed neutron system was developed for use in reactor reactivity measurements. The probe unit is small enough to fit into a reactor instrumentation pipe. The pulse-to-pulse variation in neutron output was kept to a minimum by regulating the gas pressure in the neutron tube and by maintaining the same pulsing conditions regardless of pulsing rate. The total neutron output per pulse is in excess of 10^7 neutrons, and the maximum pulsing rate is 10 pulses/sec. The neutron tube has a useful life of 10^6 pulses. The system meets the design requirements; however, some additional work may be necessary if temperatures experienced during actual operation in the reactor affect the pressure regulating system of the tube. (auth)

15237 CODES FOR REACTOR COMPUTATIONS. PROCEEDINGS OF THE SEMINAR ON CODES FOR REACTOR COMPUTATIONS HELD AT VIENNA, 25-29 APRIL 1960. (International Atomic Energy Agency, Vienna). Jan. 1961. 546p. (STI/PUB/24)

The complete proceedings of the seminar are presented. The subject is divided into five topics: Facilities for Reactor Computations, Utilization of Computers for Reactor Problems, Code Libraries Existing and Planned, Universal Languages, and Numerical and Statistical Methods. Separate abstracts have been prepared for 37 of the papers. (T.R.H.)

15238 PROGRAMMES FOR THE INVESTIGATION OF THE TRANSIENT BEHAVIOR OF REACTOR SYSTEMS USING THE FERRANTI MERCURY COMPUTER. B. E. Roberts (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). p.39-51 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

A general description is given of programs for the Ferranti "Mercury" computer which solve, by means of an implicit-difference technique, a system of first-order differential equations of basically linear form. These programs have been developed at the United Kingdom Atomic Energy Authority, Development & Engineering Group Headquarters, Risley, primarily for the investigation of the transient behavior of reactor systems and the investigation of automatic control systems. In the large majority of such problems the equations describing the system are reduced to a set of first-order total differential equations, either by using a "point reactor" representation or by the replacement of spatial derivatives in terms of finite differences. The design of the basic program was influenced by the work for which it was intended but was kept sufficiently general for the program to be of use in a wide variety of other problems which can be described in terms of such a system of equations. The method chosen for solution was a simple implicit-difference step-by-step method which is unconditionally stable in that any error introduced at one step is not magnified at the next. The necessity of iterating to solve these implicit-difference equations (by a process which is convergent for all but the most "pathological" cases) is more than offset by the larger interval, which will yield satisfactory integration as compared with similar-order explicit-difference meth-

ds. The basic program was designed in such a way as to minimize the additional programing required before a roblem was ready to go into the computer. A truly linear et of equations requires only a data tape and a test for ne termination of the run. On the other hand, varying co-fficients must be calculated by an auxiliary program. pecial versions have been developed which deal with tandard sets of equations describing point reactors. A ransient analysis for a reactor described in terms of one f these sets can be performed extremely quick. (auth)

5239 APPLICATION OF A VARIATIONAL METHOD TO THE CRITICAL CALCULATION OF A REACTOR: NUMERICAL RESULTS. G. Jannink (Electricité de France, Paris). p.429-47 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960." (In French)

One method of solving one type of boundary value problem is by the calculus of variations. It is applicable to diffusion equations with more than one neutron group, on condition that certain hypotheses regarding the diffusion operator, which is known not to be self-adjoint, are taken as true. One variation method was tested in connection with a one-dimensional two-group theory. The numerical results obtained on an average-speed computing machine illustrate the already known advantages and disadvantages of this method. (auth)

15240 MEASUREMENT OF THE ENERGY ABSORBED FROM PILE NEUTRONS. D. Binder, C. D. Bopp, and R. L. Towns (Oak Ridge National Lab., Tenn.). p.105-10 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia. American Society for Testing Materials, 1960.

Neutron threshold and resonance reactions provide a means for estimating the neutron spectrum in the pile and may be used to calculate the energy absorbed from neutrons. In order to test the accuracy of this method, threshold and resonance detectors were placed in various positions in a graphite reactor, and the results were compared to calorimetric measurements. The energy absorbed in hydrogen from fast neutrons is in agreement with values measured by the calorimetric method within errors involved in both methods. (N.W.R.)

15241 REARRANGEMENT INEQUALITIES AND NON-LINEAR STABILITY CRITERIA. W. K. Ergen (Oak Ridge National Lab., Tenn.). p.327-9 of "Proceedings of Symposia in Applied Mathematics. Vol. XI. Nuclear Reactor Theory." 1961.

The dynamic behavior of nuclear reactors is described mathematically by nonlinear differential equations. An example of the use of inequalities for such stability criteria, referring specifically to an inequality connected with rearrangements, is presented. (N.W.R.)

15242 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Graham Coates (to United Kingdom Atomic Energy Authority). British Patent 862,208. Mar. 1, 1961.

A fuel element is designed for use with gas-cooled graphite-moderated reactors. It is comprised of a hollow cylindrical sleeve (which may be graphite) having at its upper end means for supporting an array of fuel rods and at its lower end means for locating the rods horizontally while permitting downward expansion of the rods. The fuel rods are preferably of uranium dioxide, as described in Patent No. 861,222. (D.L.C.)

15243 COMPARTMENTED NUCLEAR REACTOR FUEL ELEMENT. (to U. S. Atomic Energy Commission). British Patent 862,464. Mar. 8, 1961.

An improved fuel element is designed for use in pressurized water reactors. The element consists of an elongated cladding tube with a column of fuel pellets inserted within. The fuel pellets are divided into discrete groups in compartments formed by spacing discs; the advantage of this arrangement is that thinner cladding tubes can be used and, in event of rupture in the cladding tube, the contents of only one compartment would be exposed to the coolant. In one modification of the fuel element, outer and inner cladding tubes are used with annular fuel pellets to extend the heat surface of the element, with annular spacing washers forming the compartments. Procedures are given for the fabrication and assembly of the fuel element components. (D.L.C.)

15244 FUEL ELEMENT FOR HETEROGENEOUS NUCLEAR REACTORS. (to Allmanna Svenska Elektriska Aktiebolaget). French Patent 1,200,142. June 29, 1959.

Compound fuel elements are described for heterogeneous nuclear reactors, moderated by heavy water under pressure. Each element is composed of a cluster of fuel rods surrounded by a supporting steel tube (wall thickness 0.05 mm), which is surrounded at a distance by a pressure tube, closed at its lower end. The coolant, CO_2 at 30 to 100 atm. pressure, circulates by entering the element at the upper end, flowing downwards through the outer space, between supporting- and pressure tubes and then continuing its way upwards via the supporting tube in the center, where it is heated in contact with the fuel rods, and finally leaving the upper end of the element on its way to the heat exchanger. Since the temperature of the CO_2 passing through the outer space is relatively low, a special provision for thermal insulation with regard to the surrounding heavy water is not necessary. A pressure tube made of a rather cheap metal with low neutron absorption such as Mg (with an anti-corrosion coat of Al) will serve. (NPO)

15245 PNEUMATIC EQUIPMENT FOR THE ABSOLUTE MEASUREMENT OF THE THERMAL NEUTRON FLUX INSIDE NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,201,605. Apr. 4, 1960.

For the absolute measurement of the thermal neutron flux inside a nuclear reactor, a test specimen, e.g., a gold foil, is fixed within a cartridge. The cartridge is movable inside a tube under the influence of pneumatic pressure, so that the cartridge is brought into position inside the reactor and held in this position by pressure against a stop fixed within the tube. After a predetermined irradiation period, the specimen is removed from the reactor by reversing the pressure and is brought to a suitable instrument for measuring its activity. A second tube, having an inner diameter smaller than the first tube, serves to complete a closed pneumatic circuit. (NPO)

15246 NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,203,297. Jan. 18, 1960.

The core of a nuclear reactor comprises finely divided particles suspended in a liquid. These particles consist of a combination of fissile and fertile materials. Suitably, each particle has a core of fissile material covered with a superficial layer of a material that is not fissile, or has a core of a material that is not fissile covered with a layer of fissile material. The particles may also be formed by homogeneously mixing the constituents. The material that is not fissile may be a moderator or a fertile material. (NPO)

15247 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to A.E.I. John Thompson Nuclear Energy Co., Ltd.). French Patent 1,203,611. Aug. 3, 1959.

Gas cooled reactors are referred to in which the fuel elements are contained in parallel, vertical conduits and the coolant flows in an upward direction. When the coolant flow in all conduits is practically equal, the quantity of heat absorbed per channel varies from a max. in the center to a min. in the periphery, being proportional to the neutron flux density. The resulting thermodynamical yield is not optimal. This inconvenience can be avoided by limiting the coolant flow in the outer conduits. A restricting device is designed, which is placed at the lower end of a conduit. The device consists of a pipe-shaped outer part, which can be attached to the wall at the entrance of the conduit, and a removable inner part in the middle of the outer part. An annular passage between the two parts restricts the upward flow of the cooling gas. In the lower part of the annular passage the area of the transverse section diminishes gradually in the direction of the coolant stream. Above this part the cross-section of the ring-shaped channel is constant over a certain distance. Four embodiments of the invention are described. In three of them the removable part has a support in the center of the fixed, pipe-shaped part of the restricting device. In the fourth embodiment the design is such that the supporting means is more inside the conduit. (NPO)

15248 CONTROL ROD DRIVE. (Compagnie Generale d'Electricite). French Patent 1,204,719. Jan. 27, 1960.

A nuclear reactor is described in which the control rod drive is effected by pistons sliding in cylinders, the two faces of each piston being each in contact with a pressure chamber, in such a way that the piston movement is controlled by the difference between the pressures in these chambers. One of these pressure chambers may be constituted by the reactor pressure vessel. In a one form of drive the piston is fixed directly to the control rod. In a further form the piston movements control step by step motors driving or winding off a flexible organ by which the control rod is suspended. The step by step motor comprises two ratchet-wheel drives, one for each drive direction and each in contact with one of the pistons. On disengagement of the step by step motors, the control rod falls freely into the reactor core. (NPO)

15249 PROCESS AND APPARATUS FOR SECTIONALIZING TALL (FUEL) ELEMENTS. (to S.A. Societe d'Applications des Machines Motrices et Francois de Raucourt). French Patent 1,206,048. Aug. 24, 1959.

A process and an apparatus are described for transversely and/or longitudinally sectioning tall fuel elements, which are held in a vertical position during the treatment, resting on their lower ends. The apparatus offers a means for desheathing spent fuel elements at a distance, under water or behind a thick concrete wall. (NPO)

15250 SAMPLING VALVE FOR NUCLEAR REACTORS. (to Borg-Warner Corp.). French Patent 1,206,062. Feb. 8, 1960.

A sampling valve is described which is attached to a plate having a plurality of openings. Each opening is in communication with a selected place inside the reactor and the reactor coolant. The sampling valve includes a jointed selector tube, one end of which is capable of being joined at any selected opening of the plate, while the other end is in permanent communication with a device for detecting any variation of the fluid samples taken by the sampling valve. The position of the jointed tube is controlled by selector equipment comprising organs each of which has the form of a drum. These organs cooperate with a control mechanism that determines the position of the end of the selector tube in one axis direction in the plane of the plate, according to the azimuthal position of each drum. (NPO)

15251 METHOD FOR COMPENSATING SAMARIUM IN A NUCLEAR REACTOR. (to North American Aviation, Inc.). French Patent 1,206,123. Aug. 24, 1959. (corresponding with U. S. Patent 2,843,539. July 15, 1958).

When a thermal nuclear reactor is initially brought into operation, an excess reactivity of ~1% that is built-in provides for the period during which the steady state Sm^{149} concentration is being reached. In order to compensate the excess reactivity from the beginning a mass of natural Sm (containing 13.8% Sm^{149}) substantially equal to about seven times the mass of steady state Sm^{149} is provided in the core. If in a reactor UO_2 is used as a fuel, a uniformly distributed quantity of 0.068% by weight of Sm_2O_3 to $U^{235}O_2$ is required. (NPO)

15252 NUCLEAR REACTOR CONTAINING FUEL OF SPHEROIDAL FORM. Andre Huet. French Patent 1,206,300. Aug. 24, 1959.

Fuel elements of spherical or spheroidal shape (diam. ~1 in.) are prepared by encasing U-containing material in two hollow hemispheres (e.g. of stainless steel), wall thickness ~0.05 mm. The circumferential edges of the hemispheres are turned outward and brazed together at the edge to form equatorial rims, which are then incised radially at intervals and bent to give wing-shaped fins. These fins separate the elements and allow the circulation of the cooling fluid. The cooling fluid may be used as a regulator by varying the intensity of its flow, or by mixing it with Cd moderating particles or with a suspension of fissile material. The spheroids are designed to be used stacked in baskets, in the reactor core. The distance between the baskets is variable, as a means of regulating the reactivity. Some of the spheroids have a central portion containing no fissile matter, either being empty or containing neutron reflecting material in the form of a marble. (NPO)

15253 STRUCTURE OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,206,405. Aug. 24, 1959.

An arrangement of more or less mutually connected bricks, bars, slabs, etc. is obtained by enclosing fuel material between two thin metal sheets (if desired, preshaped) closely pressed together and brazed together both along their circumference and at several points in the middle. The resulting composite sheet thus has an embossed appearance on both faces, the raised portions that enclose the fuel material forming a pattern, e.g. of separate islands, separate strips or a continuous, e.g. zig-zag, motif from one side of the sheets to the other. (NPO)

15254 METHOD FOR CARRYING OUT CHAIN REACTIONS OF NUCLEAR FISSION. (to Stichting Reactor Centrum Nederland). French Patent 1,206,632. Feb. 10, 1960.

The method consists of suspending finely divided particles comprising a fissile material, e.g., uranium oxide, in a liquid and causing this suspension to circulate through a nuclear reactor and a heat exchanger. The fission products are continually separated from this suspension during the working of the reactor. A substance is added to the circulating suspension in order to adsorb the fission products that have arisen in it. The adsorptive power of this substance for the fission products is considerably greater than the adsorptive power of the fissile material for the fission products. The adsorptive material may be separated from the suspension e.g., by a hydrocyclone, and replaced by fresh adsorbing material. (NPO)

15255 ASSEMBLING OF FUEL ELEMENTS FOR NUCLEAR REACTORS IN CLUSTERS. (to Commissariat a

l'Energie Atomique). French Patent 1,207,188. Aug. 31, 1959.

A method is described for assemblage in clusters of cylindrical nuclear fuel elements which have a number of regularly situated narrowings on their outer surfaces. The elements are assembled with their axes parallel and their narrowings at the same level; they are held together by a number of metal frames sufficient to afford adequate firmness. Each frame consists of a cylindrical belt fitting in the narrowings of the elements that are situated on the outside, while the inner elements are kept apart by short metal tubes adjusted between the narrowings. The axes of these tubes are of the same length and lie parallel to the narrowings. (NPO)

15256 SAFETY DEVICE APPLIED TO THE DETECTION OF BURSTS OF FUEL ELEMENTS IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,209,103. Feb. 29, 1960.

A safety device is described which allows instantaneous change from a defective detector unit of the installation for burst detection in nuclear reactor fuel elements. By a selector switch, situated in the reactor control room, a selected detector unit may be chosen for the change-over from among the available units, the change-over being effected in this way in a single operation. (NPO)

15257 IMPROVEMENT IN SUPPORTING FUEL ELEMENTS IN NUCLEAR REACTORS HAVING VERTICAL CHANNELS. (to Commissariat a l'Energie Atomique). French Patent 1,210,319. Sept. 28, 1959.

Each fuel element has a container which is provided with several longitudinal fins of the same length as the element, or slightly shorter. The lower ends of these fins rest on a cornice, provided in an external, concentric frame. The upper end of the frame has a groove which permits the engagement of lifting tackle designed for remote-controlled handling. (NPO)

15258 PNEUMO-HYDRAULIC CONTROL OF NUCLEAR REACTORS. (to Kernreaktor Bau- und Betriebsgesellschaft M.B.H.). French Patent 1,211,272. Mar. 15, 1960.

A nuclear reactor is described in which the neutron absorbing means are constituted by a float inside a vertical channel partially filled with the liquid moderator. The said float may be wholly closed or bell-shaped; in the latter case it is arranged so that its open end is under the surface of the moderator liquid. The reactor control may be effected by varying the moderator level inside the vertical channel, in the case of the wholly closed float, or inside the bell-shaped float; in the latter case control is effected by regulating the pressure of the gas communicating with the moderator surface whose level is to be varied. In the case of the closed float the moderator level may be varied by feeding the channel with more or less moderator liquid than is able to escape at the bottom of the channel. (NPO)

15259 AUTOMATIC EQUIPMENT FOR THE MEASUREMENT OF THE LOCAL NEUTRON FLUX GRADIENTS IN A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,211,588. Mar. 17, 1960.

For the measurement of the local neutron flux gradients in a nuclear reactor, a metal strip is activated in the reactor, and glued on a film strip. The edges of the metal strip are located at a defined distance from the edges of the film. During the measurement, the film with the metal strip is drawn through the narrow interspace formed by the scintillators of two scintillator counters, one of these being responsive to β and γ radiations, the other only to β radiation. The film movement is effected step by step, so that always a limited section of the metal strip may undergo the measurement. The widths of these sections are determined by suitable diaphragms masking partially the strip that is in front of the scintillators. (NPO)

15260 IMPROVEMENTS RELATING TO EQUIPMENT FOR THE INSERTION OF CONTROL RODS INTO NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,213,495. Apr. 1, 1960.

In order to achieve a rapid insertion of a control rod or safety rod into a nuclear reactor, the rod is arranged as a projectile inside a gun so that it can be propelled into the reactor in the event of danger. During its movement the rod slides through a tube of aluminum and is stopped by a brake tube at the end of the aluminum tube. The brake tube has an internal diameter smaller than a malleable plug that is driven into it by the rod, which is thus brought to rest. When the shot is fired, a small disc is broken that previously separated the gun from the slide tube and held the rod in place. A second plug separates the explosive charge from the rod; this plug has a slightly greater diameter than the rod and after the shot has been fired it remains wedged in the entrance of the slide tube, thus closing it and protecting it from the explosion gases. The latter escape through lateral openings in the end of the gun tube. (NPO)

15261 NUCLEAR FAST BREEDER REACTOR. (to U. S. Atomic Energy Commission). French Patent 1,215,419. Apr. 19, 1960.

Three types of fast breeder reactors are described. The reactor cores are supported inside a container so as to be spaced from the walls. Molten fuel including plutonium is arranged inside spaces bounded by the walls of suitable parallel tubes, which are in contact at their ends through headers inside the core. The amount of plutonium within the core is sufficient for critical reactivity. The tubes form a heat exchanger transferring the heat to molten sodium flowing through the core. Suitably the reactors have breeding blankets of natural uranium. Control of the reactivity may be effected by variation of the amount of molten fuel within the reactors. (NPO)

15262 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. (to C. A. Parsons & Co., Ltd.). French Patent 1,215,679. Nov. 23, 1959.

A type of complex fuel element is discussed that consists of a tubular framework formed by a plurality of spaced tubes, each containing nuclear fuel. The tubes are disposed either parallel to, or helically around a common axis. In the first mentioned arrangement the cooling fluid follows a helical path around and between the separate tubes, in the second it flows in an axial direction. Other features of this type of element are the presence of a central channel in which a control rod can be inserted, and a protecting graphite sleeve enclosing the cluster-element. (NPO)

15263 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to A.E.I. John Thompson Nuclear Co., Ltd.). French Patent 1,217,369. Dec. 7, 1959.

Nuclear fuel elements are described, each consisting of a cylindrical fuel rod, contained in a helically finned can. The can is formed with two or more circumferential grooves, axially spaced apart, fitting in corresponding grooves around the periphery of the fuel rod in such a way that there is no axial play; in the end zones similar grooves are distributed more closely over a distance equal to one half of the value of the effective container wall thickness multiplied by the square root of the quotient of the moduli of elasticity and rigidity. (NPO)

15264 EQUIPMENT FOR THE MEASUREMENT OF THE FUEL ELEMENT TEMPERATURES INSIDE NUCLEAR REACTORS. (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). French Patent 1,217,370. May 3, 1960.

A reactor fuel element is described in which one or more thermocouples are arranged within the canning material. The thermocouple junctions are connected with spring loaded contacts, which are pushed in the radial direction against contact pieces attached to the inner wall of the fuel element channel, at places corresponding to the working positions of the fuel element. These contact pieces are in further connection with the measuring instrument. The contact pieces are suitably fitted in a piece of ceramic material and form a part of its surface. These ceramic pieces have inclined surfaces close to the contact pieces so that the spring loaded contacts reach to the channel wall only at the working position of the fuel element. (NPO)

15265 METHOD FOR A NEW STARTUP OF A NUCLEAR REACTOR AFTER A SHUT-DOWN, USING MEANS THAT INTRODUCE A SUPPLEMENTARY REACTIVITY. (to Atomic Energy of Canada Ltd.). French Patent 1,217,437. May 3, 1960.

A nuclear reactor working with natural uranium as fuel, or with slow enriched uranium, or with a fuel composition equivalent to the latter, has a slow excess reactivity, so that the xenon poisoning that arises after a shut-down can only be overcome by the insertion of means introducing a supplementary reactivity into the reactor; these means remain inserted inside the reactor only during the new start-up. These means may be constituted by supplementary fuel elements of nearly pure fissile materials. The insertion of these elements may bring about a rise of reactivity between 5 and 15 milli-K. (NPO)

15266 EQUIPMENT FOR THE INDICATION OF MAGNETIC COUPLING. (to A.C.F. Industries, Inc.). French Patent 1,218,033. May 6, 1960.

A description is given of a nuclear reactor in which the control rods are connected to the control drive organs by electromagnetic coupling means. To insure unfailing control, the impedance of the induction coil of the coupling device is constantly checked; any essential impedance variation induces reactor shut-down. The coil is fed by a direct current and forms at the same time a part of an arm of a measuring bridge fed by an alternating current; the direct current is unable to influence the balance of the bridge. Any variation in the impedance of the coil causes a voltage to arise at the measuring terminals of the bridge and this voltage controls the reactor shut-down. (NPO)

15267 FUEL ELEMENT FOR NUCLEAR REACTORS. (to General Electric Co.). French Patent 1,220,386. Jan. 4, 1960.

Solid fertile material of cylindrical or other suitable shape is covered by a layer containing fissile material, which in its turn is enclosed or bounded by an immediately adjacent container wall, acting as a heat transfer surface for the element. The fertile material consists of U^{238} or Th^{232} or of U alloyed with either Al, Be, Cr, Fe, Pb, Mn, Ni, Sn, Ti or Zr. As fissile material U^{235} is initially used and later on Pu^{239} or U^{233}. The volume of the "fissile" layer comprises 1 to 40 vol.% (generally 20%) of the total volume of the fuel element, not counting that of the container. This construction can be adapted to rod-shaped, tube- or plate-type fuel elements. (NPO)

15268 SHIELDED THORIUM FUEL ELEMENT. (to General Electric Co.). French Patent 1,222,018. Jan. 18, 1960.

A type of element is proposed which consists of a body of Th^{232} containing fertile material. The element is provided with an adjacent layer, substantially of U^{238}, enriched by fissile material, preferably by Pu. This layer acts as a shield having neutron resonances ranging from 0.05 to about 10.0 ev in order to limit as much as possible neutron capture by Pa^{233} during conversion of Th^{232} to U^{233}. (NPO)

15269 IMPROVEMENT IN NUCLEAR REACTORS. (to Le Carbone-Lorraine). French Patent 1.222.744. Jan. 25, 1960.

A reactor core is proposed which is assembled from cubical, parallelepipedal, hexagonal, or cylindrical graphite elements which are provided with two series of mutually perpendicular channels. Thus two channel systems are formed, one for the circulation of the coolant and the other for the insertion or circulation of the fuel. (NPO)

15270 NEW AUTOMATIC SELECTION EQUIPMENT FOR THE DETECTION OF BURSTS OF FUEL ELEMENTS IN HETEROGENEOUS NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,223,591. June 17, 1960.

In order to detect bursts of fuel elements, sampling lines deliver a part of the reactor coolant from each reactor channel to equipment which is able to detect any excessive radioactivity in the coolant. The samples are switched to this equipment in a predetermined manner. The switching operations are controlled by a single electric rotary switch, driven by an electric motor until an excessive activity is detected. In case of excessive activity this switch initiates the working of a detecting unit of a second type, which is able to locate the exact origin of the detected excessive activity. (NPO)

15271 IMPROVEMENTS RELATING TO SWIMMING-POOL REACTORS. (to Societe Indatom). French Patent 1,224,251. June 23, 1960.

For the high power operation of a swimming pool reactor, a removable cover is placed in the pool so as to separate the reactor core and a part of the pool water from the remaining pool water, which is above the cover. The cover is tight enough to prevent an escape of fission products through the surface of the water in the pool. Under the cover, made up of a central and a peripheral part that are independently removable, the tube coils of a heat exchanger cool the pool water. (NPO)

15272 NEUTRON MODERATOR. (to Fluitherma (Chauffage Industriel à Haute Température)). French Patent 1.231.055. Apr. 11, 1960.

The application of squalane as a moderator substance in nuclear reactors is proposed. Advantages of this compound are high hydrogen content, high radiation and temperature resistance, high b.p. (375°C), low m.p. (−20°C), low density (0.7 g/cm^3), good heat-transfer properties, and chemical inertness. (NPO)

15273 SHIM RODS FOR NUCLEAR REACTORS. (to Siemens-Schuckertwerke A. G.). German Patent DAS 1 055 709. Apr. 23, 1959. (In German)

The patent is concerned with cases in which an additional site-concentrated neutron flux peak must be compensated. For this purpose it is proposed that a mass of neutron absorbing material be applied to the ends of control rods. (J.S.R.)

Power Reactors

15274 (AEPSC-632) PROTOTYPE AND FULL-SCALE POWER PLANTS GAS-COOLED REACTOR PROJECT. Progress Report No. 4. (American Electric

Power Service Corp., New York). Sept. 1, 1960. For East Central Nuclear Group and Florida West Coast Nuclear Group. Contract AT(38-1)-200. 117p.

Development and application of the gas-cooled, heavy-water-moderated, pressure-tube-type reactor concept is discussed. Major revisions were made in the reference design of the 50-Mw prototype power plant. The reoriented research and development program resulted in a new reactor design which substitutes beryllium for stainless steel as the fuel cladding material and employs top-mounted vertical control rods. The extremely low moisture content of the CO_2 required for beryllium allowed a more definitive approach to the design of the CO_2 purification system. The steam generator specifications were revised to obtain the most feasible integrity against water and/or steam leakage. Results from the corrosion testing program indicated that the previously selected Croloy materials are not suitable for use in the high-temperature regions of the CO_2 coolant system. The Croloys were replaced in the system by stainless steel. Re-evaluation of the heat cycle economics resulted in a change to the non-reheat cycle for the prototype reference design. Inlet-valve-controlled main CO_2 blowers with constant speed squirrel cage motors were chosen over less economic alternates. A more compact arrangement of the prototype reactor and CO_2 coolant system permitted a reduction in the diameter of the containment vessel. Other changes, particularly the development and incorporation of a conceptual waste handling system, required an increase in the containment length. D_2O and helium blanket purification systems were modified to handle the expected CO_2 leakage into the D_2O moderator through pressure tube joints. A re-estimate of the capital cost of the plant showed a moderate decrease due primarily to the shift to the non-reheat cycle. Revisions of the plant arrangement and further development of the auxiliary, clean-up, and waste handling systems were included in the revised layout drawings. (For preceding period see AEPSC-623.) (auth)

15275 (ANL-6301) IDAHO DIVISION SUMMARY REPORT, JULY, AUGUST, SEPTEMBER 1960. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 146p.

Experimental Breeder Reactor I. The fully ribbed and rigid Mark III loading of EBR-I was found to be governed by feedback processes which guarantee safe and stable operation under normal operating conditions and to give a large radial contribution to the power coefficient. Nonlinearities in the power coefficient were investigated and found to be no problem. If the stabilizing ribs are removed from the fuel rods, a strong positive effect appears which is associated with the inward bowing of fuel rods. The prompt positive coefficient observed in Mark II is discussed from the standpoint of Mark III tests. A 800-Mwh irradiation run was made on a number of samples, and some brick cladding failures are reported. Data are given for the dimensional changes in EBR-I, Mark III fuel rods used for a total of 2,682 Mwh operating time; the fuel rods usually increased in diameter and decreased in length, and some bowing was observed. The growth and temperature profiles of the fuel rods are compared, and the effects of radial restraint on the rod growth are discussed. The EBR-I, Mark IV core design is then discussed. The fuel rod will incorporate four plutonium-10 at.% aluminum fuel slugs with two depleted uranium blanket slugs. Calculations were made on the critical mass of Mark IV, which is shown to be 28.3 kg of total plutonium. Zero-power Reactor III (ZPR-III). A mockup of EBR-II was studied in ZPR-III, and the worth of the mockup control rods was evaluated with tantalum and B_4C followers. An EBR-II B_4C oscillator rod experiment was made in which the excess reactivity was measured as a function of the angular position of the oscillator. The worths of sodium, aluminum, and stainless steel were mapped throughout the core and blanket. From substitution experiments, there appears to be some spectral differences at the center of the clean cores, depending on whether the core is filled with sodium or aluminum. A two-dimensional mapping of the worth of U^{235} and U^{238} was also performed, and their fission rates were determined. Since the EBR-II shields and thimble holes have been redesigned, new mockups were made and their counter responses studied. Transient Reactor Test Facility. The equipment and procedures used to obtain constant power or flat top pulse bursts for transient testing of fuel elements are described. The poison sections of the control rods were modified by mixing epoxy resin with graded boron carbide to prevent poison movement. The radiation effects of pulsed bursts on pressure transducers were studied, and it was found that the extraneous pressure signal following the instantaneous power, but not that following the integrated power, can be eliminated. Boiling Reactor Experiment V (Borax V). A general review is given of work done to date, and the design of the reactor and plant is discussed in detail. The core structure is discussed, particularly the spring which allows differential expansion between the core structure and the reactor vessel. A comparison of boiling fuel rods with different diameters is given. The superheater fuel assembly was redesigned with 4 instead of 5 fuel plates because the maximum surface temperature has been lowered from 1200 to 1100°F. The reactor control system is compared with those of previous BORAX reactors and EBWR. The construction of the control rods is discussed; the control rod drives which are to be used are those originally used on EBWR. The fuel handling system is discussed. The programs for testing superheater–fuel assembly seals and developing in-core instrumentation are described. Argonne Fast Source Reactor (AFSR). The present status of AFSR is discussed. Data are presented for the neutron fluxes at various points in AFSR and for the AFSR dimensions. (D.L.C.)

15276 (APAE-39) DESIGN ANALYSIS OF A PREPACKAGED NUCLEAR POWER PLANT FOR AN ICE CAP LOCATION. (Alco Products, Inc., Schenectady, N. Y.). Jan. 15, 1959. Contract DA-44-009-eng-3638. 483p.

A design analysis is given for a nuclear power steam-electric generating plant, which is air transportable, skid mounted, and of the pressurized water design. The analysis was made of the plant, primary and secondary systems, and reactor design. (B.O.G.)

15277 (BAW-1218) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. Quarterly Technical Report No. 2, October–December 1960. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Contract AT(30-1)-2602. 66p.

Basic physics parameters are being determined for lattices of slightly enriched fuel in moderators consisting of D_2O–H_2O mixtures of different concentrations. The principal effort was devoted to procurement and erection of equipment and materials needed for the critical experiments with D_2O in the moderator, the exponential experiments, the hot exponential experiments, and the neutron age experiments. The erection of these facilities and the D_2O handling system was completed and checked out. The fuel rod preparation was completed, and all necessary hazard

evaluations and license applications were submitted. Two critical experiments with 4%-enriched UO_2 fuel and H_2O moderator (one clean and one poisoned with boric acid) were completed. In these cores the critical mass, critical buckling, thermal disadvantage factor, and cadmium ratio of U^{235} were measured and the data are reported. The BPG computer code, which will be used to analyze the experiments with D_2O in the moderator, was completed and checked out. The accuracy of the code was checked by computing a variety of H_2O and D_2O moderated critical experiments and applicable neutron age measurements and comparing results with those obtained by other standard calculational methods. Calculations supporting the planning and design of the experiments also continued. (auth)

15278 (CF-61-3-99) EGCR GRAPHITE PERMEABILITY TESTS: RESULTS OF FORCED FLOW EXPERIMENTS ON EGCR MODERATOR-GRADE GRAPHITE. W. T. Ward and J. Truitt (Oak Ridge National Lab., Tenn.). Mar. 24, 1961. 17p.

Helium-permeability and porosity were determined at room temperature for specimens from a typical EGCR moderator-grade graphite block. Permeability, at a mean pressure of 2 atm, ranged from 26 to 200 (av. 86.5) millidarcys. Permeability data indicated that turbulent flow was never obtained with helium in these tests and that helium permeating the moderator graphite at EGCR operating conditions (taken to be: 600°C; ΔP, 10 lb/in.^{2} per inch of graphite; mean P, 400 lb/in.^{2}) was in the viscous flow region. Darcy's law and the reported constants are applicable for flow computations involving moderator graphite under these conditions. Porosity ranged from 20.6 to 29.4% (av. 23.8%), and there was no correlation between porosity and permeability variations. The large variations encountered were believed to reflect the nonuniformity of the specimens, since duplicate determinations showed excellent agreement. Permeability did not change appreciably with direction of flow and did not vary consistently with respect to the extrusion or any other axis. Preparation of the specimens did not appear to introduce appreciable surface effects. (auth)

15279 (GAMD-984) SHUTDOWN HEAT GENERATION IN HTGR. D. C. Morse (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 16, 1959. Contract AT(04-3)-314. 7p.

An estimate is given of the heat generation in the HTGR after shutdown for cooling times of 10 sec to 100 days, assuming that the reactor fuel is U^{235} only. The ratio of shutdown power to operating power, P/P_0, is given as a function of time after shutdown. The effects of delayed neutrons, and Pa^{233} and Th^{233} decay are considered. The unclad version of HTGR is specifically considered, but the results may be applied to the metal-clad version with reasonable accuracy. Release of fission products from fuel elements is not considered. (B.O.G.)

15280 (IDO-16648) MATERIALS TESTING REACTOR–ENGINEERING TEST REACTOR TECHNICAL BRANCHES QUARTERLY REPORT, APRIL 1–JUNE 30, 1960. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 25, 1961. Contract AT(10-1)-205. 72p.

Satisfactory operation of the ETR with the GEANP-99M7 experiment installed was indicated with changes in loading and rod withdrawal sequence developed in the ETRC. The variation in other experimental fluxes in the ETRC due to withdrawal and insertion of the two GEANP experiments proposed during operation of the ETR are relatively small. Detailed horizontal neutron flux maps within the 400-g ETR fuel elements established more accurate constants for extrapolating ETRC fluxes to "full power" ETR values and for determining heat transfer limitations. Comparison of a black and a gray absorber section on control rod No. 13 when partially inserted as a regulating rod shows at most only 7% more flux depression for the black section than for the gray. It is shown that, for 400-g ETR fuel elements, 10% more boron in polyethylene tapes is required in order to be equivalent to boron uniformly distributed in the coolant space. Changing the metal-to-water ratio of the fuel elements in the ETR from 0.644 to 1.210 without a change in charge life is found to cause a 20% increase in thermal neutron flux in the inpile experiments for the 11% increase in U^{235} required. The vertical thermal neutron flux distribution in each ETR fuel element was determined during Cycle 27 for the clean core and for the depleted core. Calculations were made of the integrated power following a junior scram in the ETR for varying rod worths to determine the protection afforded by their use. Comparisons of calculated and measured thermal neutron fluxes in the ETRC were made for variation in calculation techniques and reactor physics constants. The full program of 14 capsules containing oxide fuel in the fuel element development program for the Experimental Gas Cooled Reactor is now installed in the ETR with the total burnup now ranging from 500 to 2500 Mwd/MT. Fundamental studies of the metal-water reaction of aluminum–23.4 wt.% uranium alloy indicate very low reaction rates up to 2300°F. Calculations made to maximize the production of U^{233} + Pa^{233} from thorium slugs without exceeding a given heat generation rate indicate that the most efficient method is to use two different fluxes. A preliminary measurement of the Co^{58} thermal cross section indicates that the 1500 b value makes a sizeable correction in the calculation of fast neutron fluxes from the threshold reaction $Ni^{58}(n,p)Co^{58}$. Preliminary total cross section data on Pa^{231} and Pu^{241} were taken with the MTR chopper. Crystal spectrometer measurements on the variation of eta for U^{233} in the region 0.01 to 1 ev were compared with eta values obtained from MTR fission and total cross section data and with measurements made in other laboratories. Time-of-flight analyses of Bragg beams from beryllium crystal planes demonstrate the necessity of making such studies prefatory to high precision measurements. An investigation made into the system design of the MTR crystal spectrometer shielding cart drive to determine the system response to increasing the drive speed by a factor of 10 indicates that with appropriate design changes a stable system to meet the requirements can be obtained. In the MTR nuclear chemistry program, results from triplicate analyses of the gas produced in highly irradiated beryllium are found to agree with yields of these gases calculated from cross sections and the neutron irradiation history. More accurate values for the half life of Cs^{134m} (2.90 ± 0.01 hr) and for its formation cross section (3.45 ± 0.2 b) were obtained at the MTR. The activation yield ratios of metastable and ground states for Rh^{104} and Ir^{192} were determined at thermal and at low energy resonances. Results giving comparisons among Au, Mn, and Na thermal and resonance flux monitors show good agreement. The activation thermal cross sections and resonance integrals for Pm^{147} going to the 5.3 and 42 day Pm^{148} isomer, the pile cross sections of both isomers of Pm^{148}, the decay characteristic of 53 hr Pm^{149}, and gamma ray abundances for these activities were measured. In the inelastic scattering of slow neutrons program, energy and angular distribution measurements of slow neutrons scattered from methane were compared with theoretical spectra and condensed to the "Scattering Law" presentation proposed by Egelstaff. The decay of 15 day Eu^{156} was studied to produce a level scheme for Gd^{156}. Recent measurements

were made to determine the spins and parities of some of the previously reported energy levels using gamma-gamma directional correlation techniques. The differential cross section of methane was calculated using the approximations of Krieger and Nelkin which greatly simplify the computations, and a method which is rigorous except for treating rotations classically. The two methods agree very well for neutron energies up to 0.1 ev and give good over-all agreement with data obtained on the MTR slow neutron velocity selector. (For preceding period see IDO-16633.) (auth)

15281 (K-1468(Pt.I)) TRANSIENT HYDRODYNAMIC OPERATION OF EGCR MAIN COOLANT SYSTEM. D. W. Burton (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 14, 1961. Contract W-7405-eng-26. 29p.

The main helium coolant system of the Experimental Gas Cooled Reactor (EGCR) is described. The relations describing the hydrodynamic behavior of the coolant loops are derived and discussed. Methods of solving these relations are outlined, but no solutions are presented. (auth)

15282 (NAA-SR-4884) OPERATION AND ANALYSIS OF A 3000 KW LIQUID METAL MODEL STEAM GENERATOR. L. J. Webster, ed. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 28, 1961. Contract AT(11-1)-GEN-8. 211p.

A 3000-kw(thermal) bayonet duplex tube model steam generator was performance-tested in a liquid metal test loop at MSA Research Corporation, Callery, Pennsylvania, under the cognizance of Atomics International. The steam generator was fabricated of 2-1/4%Cr–1%Mo steel and consisted of an evaporator, moisture separator, and superheater. Two configurations of the steam generator were tested and each was tested in a different portion of the test program. The first configuration included a superheater and a natural-circulation evaporator, and was tested mainly to demonstrate the practicality of designing and operating a liquid sodium-heated steam generator. The second configuration tested incorporated the same superheater and evaporator heat transfer tube bundle, but a new "kettle" type evaporator shell with integral moisture eliminator and a new evaporator core tube bundle were installed. The second configuration was tested mainly for the purpose of proving the feasibility of the design for application to similar full-scale steam generators for the Hallam Nuclear Power Facility, each of 84,500 kw(thermal) capacity. A two-tube model superheater of 5%Cr–1/2%Mo and a trace of Ti in the heat transfer tubing was also installed and tested in the loop during the test program of the second configuration of the model steam generator. It was tested mainly for the purpose of evaluating this material for superheater application. Both configurations were operated at steady state and various transient conditions during their respective test programs. The cumulative operating time totaled 8451 hours, 4926 hours of which were applicable to the testing of the natural-circulation unit and the remainder to the kettle-type unit. Over-all heat transfer coefficients determined by analysis of the model steam generator on an analog computer ranged from 1032 Btu/hr-°F-ft^2 at startup to 850 Btu/hr-°F-ft^2 at the end of the operating period for the natural-circulation unit. The heat transfer coefficient at startup for the kettle-type unit could not be readily determined due to a thermocouple fault during initial operations. It was, however, estimated to be approximately 860 Btu/hr-°F-ft^2 at startup. The coefficient decreased to nominally 755 Btu/hr-°F-ft^2 at the end of the operating period. These coefficients were also determined using the analytical techniques as applied to the natural-circulation unit. The superheater heat transfer coefficient at startup was 206.5 Btu/hr-°F-ft^2 and was observed at the end of 8541 hours of operation to be approximately 170 Btu/hr-°F-ft^2 with a minimum at one point of approximately 100 Btu/hr-ft^2 due to excessive carryover of boiler water solids. Except for a steam-to-third-fluid leak attributed to a manufacturing error, which occurred 250 hours after initial startup, the integrity of the steam generator was maintained throughout the test program without incident. The two-tube model superheater was removed from the test loop after 2460 hours of operation and examined. No deleterious effects were found. Operating problems with respect to the steam generator were virtually non-existent except for excessive pressure drops that occurred on the steam side of the superheater. These excessive pressure drops were attributed to carried-over boiler water solids which deposited in the superheater, eventually causing the flow passages to become plugged. This problem was eliminated in the latter stages of the test program by changing the boiler water treatment from solid chemicals to volatile chemicals using hydrazine and morpholine. (auth)

15283 (NAA-SR-Memo-730) DIPHENYL AS A REACTOR COOLANT. T. T. Shimazaki (North American Aviation, Inc., Downey, Calif.). July 1, 1953. 7p.

A study was made to determine optimum operating conditions for a specific power reactor when diphenyl is employed as the reactor coolant. It was assumed that: the fuel element consists of 7 uranium alloy rods clad in zirconium; the coolant tube inside diameter is 2.80 in.; coolant flow rate is adjusted for maximum possible outlet temperature, but not in excess of 750°F; and the coolant velocity was limited to 20 ft/sec. Results are presented in graphical form. A comparison was made between diphenyl and sodium as coolants. (M.C.G.)

15284 (NAA-SR-Memo-1607) THERMAL POWER OF OMRE REACTOR. T. T. Shimazaki, R. O. Williams, Jr., and R. F. Wilson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 28, 1956. 14p.

The hot channel factors for the OMRE reactor were evaluated and the thermal power of the OMRE calculated from these experiments. The heat generation distribution was taken to be the same as the thermal neutron flux distribution. The thermal power calculated by using the hot channel factors is conservative since the values for these factors are determined on the basis that the various factors contributing to a hot spot would all occur and at the same point. It was concluded that the OMRE reactor is capable of operating at a thermal power of at least 11.8 MW without exceeding a coolant-fuel plate interface temperature of 800°F when the coolant inlet temperature is 500°F and the coolant velocity between fuel plates is 15 ft/sec. (M.C.G.)

15285 (NAA-SR-Memo-1775) REVIEW OF OMR CRITICALITY. John Cobb (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 14, 1956. 71p.

Calculations were made to accurately predict the behavior of the OMR. The methods for these calculations were based on a two-group, three-region method, with only the center region multiplying. A general description is included. Reactor constants are given. Flux distributions were calculated for the fuel plates and cells. Average flux, fission product poisons, burnup and conversion, and fuel element removal are discussed. A plot of reactivity as a function of uranium enrichment and temperature of the reactor is given. (M.C.G.)

15286 (NAA-SR-Memo-1783) INTERIM PROGRESS ON THE STUDY OF THE APPLICATION OF AN ORGANIC

MODERATED REACTOR FOR PROPULSION OF A 50,000 TON MARINE TANKER. R. J. Gimera (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 15, 1956. Decl. Nov. 6, 1958. 10p. Contract AT-11-1 (GEN-8).

A study was made of the application of an organic moderated reactor (OMR) for propulsion of a 50,000-ton marine tanker. The reactor core concept was that of a uniformly loaded, slightly enriched, hydrocarbon moderated and cooled core. Discussions of the organic purification system, gas handling system, piping and instrumentation diagram, reactor core layout, fuel element locking device, fuel handling system, and radiation shielding calculations are included. A three-group diffusion model was used to investigate the behavior of neutrons in a flat thermal flux core. (M.C.G.)

15287 (NDA-2131-6) DESIGN EVALUATION AND COMPARISON 200 MWe BOILING D_2O PRESSURE TUBE INDIRECT AND DIRECT CYCLE POWER REACTOR PLANTS. (Sargent and Lundy, Chicago and Nuclear Development Corp. of America, White Plains, N. Y.). June 30, 1960. Contracts AT(38-1)-213 and AT(30-1)-2303 (IX). 112p. (SL-1776)

The engineering and economics of 200-Mwe D_2O-moderated power reactor plants were evaluated for both direct and indirect cycles with boiling D_2O-cooled pressure tube reactors. Comparison of the cost estimates indicates that the reduction in cost due to smaller D_2O inventory in the turbine plant in the indirect cycle does not offset the additional cost of the steam generators and preheaters. The cost difference of 0.1 mill/kwh power between the two cycles indicates that the two cycles are essentially economically equivalent. (D.L.C.)

15288 (NMI-7233) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, AEC, for the Period October 1, 1960 through October 31, 1960. S. Isserow, A. M. White, H. F. Sawyer, E. F. Jordan, W. L. Larson, W. J. Richmond, H. M. Green, P. R. Smoot, A. D. Donaldson, A. R. Gilman, and W. B. Tuffin (Nuclear Metals, Inc., Concord, Mass.). Dec. 8, 1960. Contract AT(33-1)-1565, Sponsor Agreement No. S-31. 34p.

Processing continued on the set of five thin-walled outer tubes comprising the demonstration set and on tubes 95 and 97, which were previously carried as far as the heat treatment which included an oil quench. Two prototype inner tubes, Nos. 103 and 104, were heat treated and processed. The tubes were shipped to SRL. Borescopic examination of defects on the inside of tube 82 (U–1.5 wt.% Mo) indicated that they are insignificant. Companion tube 83 was retained in the as-extruded condition for possible future processing. Tube 113, an unalloyed vallecitos prototype, had a short uniform core and long tapers but acceptable cladding thickness. Two enriched tubes, Nos. 114 and 115, were extruded from billets of identical design. Additional bend tests were made on specimens with unalloyed and U–1 wt.% Si cores. As in the case of the U–1.5 wt.% Mo specimens which were reported earlier, the unalloyed uranium specimens developed cracks in the cladding-core interface at relatively low strains. The U–1 wt.% Si specimens, like the U–2 wt.% Zr specimens reported earlier, were essentially free of cracks below the fracture strain. The fracture strain for the U–1 wt.% Si specimens was lower than that for the unalloyed uranium. The two different modes of deformation and failure suggested that there is no simple relationship between in-pile performance and ductility as defined by strain at fracture. Two U–1 wt.% Si castings were made and heat treated. Castings were also made of dingot uranium, U–0.3 wt.% Al–0.5 wt.% Si alloy and U–0.3 wt.% Cr–0.3 wt.% Mo alloy. Braze alloy for assembly of capsules is also being prepared. Experiments were begun for establishing the heat treatment and processing sequence for the U–Al–Si alloy. Uranium dispersed in magnesium and clad with Zircaloy appeared to have advantages as a fuel system. A program to investigate this system was initiated with the immediate objective of studying Zircaloy-magnesium bonding and interdiffusion. A program was also initiated to develop a transient zone melting technique for producing a cast structure in the cores of Zircaloy-clad fuel elements. Construction of an apparatus for the melting is underway. Laboratory experiments and two additional extrusions were made in attempts to gain an understanding of the outer edge irregularities of stainless steel-Zircaloy joints. Evidence was obtained that differential thermal contraction could be a major cause of the difficulty. (For preceding period see NMI-7232.) (M.C.G.)

15289 (NMI-7234) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, AEC for the Period November 1, 1960 through November 30, 1960. S. Isserow, A. M. White, H. F. Sawyer, E. F. Jordan, W. L. Larson, W. J. Richmond, H. M. Green, P. R. Smoot, A. D. Donaldson, A. R. Gilman, and W. B. Tuffin (Nuclear Metals, Inc., Concord, Mass.). Jan. 20, 1961. Contract AT(30-1)-1565, Sponsor Agreement No. S-31. 32p.

Processing of the five outer tubes of the demonstration set and two earlier tubes was completed. It was noted that bowing is a more serious problem for these thin-walled tubes than for thick-walled tubes and is related to the slight non-uniformity of wall thickness. Considerable effort was expended in comparing cladding thickness measurements as determined by autoradiography with those obtained by eddy current measurements. While not completely reconcilable, the two methods are not far apart. On several of the tubes, the thinnest cladding was not associated with the core end shape. Billets for a demonstration set of six inner tubes were assembled for extrusion. The billet design was similar to that used for satisfactory Tubes 103, 104 and 105 except that the core length was increased slightly. Autoradiography results for unalloyed Vallecitos Tube No. 114 caused some doubt as to the adequacy of the cladding thickness at some locations. Tube 114 was fully processed and will be re-autoradiographed in about two months to resolve whether the apparent thin spots were caused by radioactive decay products. Additional bend tests, conducted while recording the load-deformation curves, indicated that the shapes of the curves are not influenced by the mode of fracture. It appeared that the mode of fracture of U–2 wt.% Zr specimens is not entirely similar to that of U–1 wt.% Si but characterized also by some of the features of the failure mechanism of U–1.5 wt.% Mo specimens. A brittle core, even with a ductile interface (as for beta treated U–1 wt.% Si specimens), caused the most brittle failures. A brittle diffusion zone (as for diffusion heat treated U–2 wt.% Zr specimens) caused less loss of ductility. For the preparation of capsule specimens of various compositions, a satisfactory coextrusion was made with a low-carbon U–1 wt.% Si core, a satisfactory core was prepared and a billet assembled for coextrusion of specimens with unalloyed dingot uranium cores, and progress was made in determining the heat treatments for U–0.3 wt.% Al–0.5 wt.% Si alloy and U–0.3 wt.% Cr–0.3 wt.% Mo alloys. In addition, a Zircaloy-4 tube was extruded for subsequent machining into end caps and the preparation of braze alloy is under way. After experimenting with various techniques, 24 magnesium-Zircaloy-4 diffusion couples were prepared by melting magnesium around the Zircaloy-4. Subsequent solid state diffu-

sion at 300, 400, 500, and 600°C for various times will be determined by measuring the additional penetration. Attempts are being made to produce a casting of Mg–0.4 wt.% Si for use in making comparable diffusion couples. Significant progress was made in the construction of an apparatus for transient zone melting of tubular fuel elements. Laboratory experiments and examination of new tubular and rod extrusions have shed no additional light on the cause of irregularities at the interface on the outside surfaces of extruded stainless steel-Zircaloy joints. (For preceding period see NMI-7233.) (M.C.G.)

15290 (NP-9883) OPERATION REPORT NO. 1. Initial Startup and Test Operations of the Yankee Reactor for the Period July 9, 1960–January 29, 1961. (Yankee Atomic Electric Co., Boston). Feb. 13, 1961. 54p.

Descriptions are given of: the reactor core loading, assembly, and instrumentation check-out; cold and hot control-rod scram tests; reactor startup; reactor physics testing at power levels below 5 Mw(t); power operation performance testing; a 500-hr full-power test run at 392 Mw(t); a chemical evaluation of the plant system; health physics monitoring results; the evaluation and installation of some plant systems and thin components; design and operating procedure changes; and a test procedure for determining the plutonium buildup. (B.O.G.)

15291 (PRDC-TR-39) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES FOR] SEPTEMBER 1960. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 26p.

Research and development activities on the Fermi Fast Breeder Reactor are summarized under the following headings: core design, materials and metallurgy, nuclear engineering, health physics, reactor vessel engineering, mechanical handling, instrumentation, liquid metal and steam systems, and test operations. An environmental radioactivity report is also included. (M.C.G.)

15292 (PRDC-TR-40) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES FOR] OCTOBER 1960. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 26p.

Development of the Fermi Fast Breeder Reactor is reported in terms of core design, nuclear engineering, materials and metallurgy, mechanical handling, instrumentation, liquid metal and steam systems, and test operations. The status of the PRDC preoperational, environmental survey and the results of airborne dust sampling and analyses are given. (M.C.G.)

15293 (PRDC-TR-41) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES FOR] NOVEMBER 1960. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 16p.

Development of the Fermi Fast Breeder Reactor is reported in terms of core design, materials and metallurgy, nuclear engineering, mechanical handling, liquid metal and steam systems, instrumentation, and test operations. Results of the airborne dust sampling and analysis program are included. (M.C.G.)

15294 (TID-8529) EVALUATION AND DESIGN HEAVY WATER MODERATED POWER REACTOR PLANTS. (Sargent and Lundy, Chicago). June 30, 1960. Contract AT(38-1)-213. 178p.

The 200 and 300 Mw(e) boiling D_2O direct-cycle plant designs have undergone design revisions which substantially affect their power costs. The revisions resulted from incorporating improvements, that were originally made for the 70 Mw(e) direct-cycle prototype plant, into the full-scale plant designs. The results of other studies which relate directly to heavy water moderated reactors, particularly to those cooled by boiling D_2O, are summarized. The investigations were concerned with D_2O equipment component leakage, power plant construction materials and plant arrangements. (auth)

15295 (WCAP-4052) CVTR PROJECT, CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. MONTHLY PROGRESS REPORT, FEBRUARY 1961. (Westinghouse Electric Corp., Atomic Power Dept., Pittsburgh). Contract AT(30-1)-2289. 28p.

A new pressure tube wall thickness was established, using the criteria established for Reference Design II but based upon higher material properties and new values of design temperature and pressure. The new minimum wall thickness is 0.184 in., compared to the value given in Reference Design II of 0.253 in. The impulsive burst testing of pressure tubes was started with successful runs at low energy levels. However, difficulties developed with a trigger mechanism during high energy tests, necessitating some redesign and repair. Heat leakage data from Phase II tests indicate that the ball and cone type seal between the thermal baffle and pressure tube is effective. Heat losses appear to be less than the 4.6-Mw design value. Fifty thermal cycles were recorded on the refueling port with no indication of leakage. Two hundred cycles were accumulated on the jumper connector and port test fitting with no sign of leakage. The contact conductance between UO_2 and Zircaloy-2 with an interface pressure of 275 psi was measured as 800 Btu/hr ft^2/°F. In the testing of the control rod drive train and drive mechanism, the mechanism did not put out enough torque to turn the system so a gear motor was substituted. The initial tests were made with the motor connected to the inner shaft. Appreciable control rod flutter was noticed so the rod and motor were switched to the outer shaft. One thousand test cycles were successfully completed in the control system. The coolant void coefficient was measured in the critical facility with 98% pure D_2O and found to be positive at the edge of the core and negative in the center. Some planned irradiation experiments are reported. (For preceding period, see WCAP-4051.) (auth)

15296 NUCLEAR REACTOR PLANTS FOR SHIPS. K. Illies. Atomkernenergie, 6: 1-8(Jan. 1961). (In German)

The many reciprocal actions between different parts of a ship propulsion-plant are pointed out. These reciprocal actions do not permit the planning engineer to leave out of consideration some individual plant parts and take them as being given; this includes also, for instance, the reactor, with whose physics and technical matters the engineer has to occupy himself. Furthermore, the connections of the engine with the ship itself is particularly mentioned; the engine can never be considered or judged alone but only in connection with the ship. This is also important from the economic point of view. Referring to what is particularly expected from marine-engines, different from other engines, some examples of the planning, the construction, and the economic point of view are discussed with regard to nuclear ship propulsion plants. Finally, the attention is drawn to something which is inavoidable in all technical development, i.e., the necessity to get practical experiences; in this special case it would be a research ship with a nuclear propulsion plant. (auth)

15297 CRITICAL EXPERIMENTS FOR ADVANCED EPITHERMAL THORIUM REACTOR. D. T. Eggen (Atomics International, Canoga Park, Calif.). Atompraxis, 7: 17-23 (Jan. 1961). (In English)

The Advanced Epithermal Thorium Reactor concept,

using a Th–U^{233} fuel cycle, sodium coolant, and operating with a non-thermal neutron energy spectrum, shows potential in achieving economical electric power. A laboratory has been designed and constructed, and a novel critical assembly was designed as a multiregion reactor, so that a small amount of U^{233} fuel is supplemented with enough U^{235} to achieve criticality. The AETR critical assembly will validate computer codes over the range of neutron energies being considered, and by special techniques develop integral nuclear parameter data. Developmental goals of the AETR are being achieved, and results to date indicate that a Th–U^{233} reactor operating in the epithermal intermediate-neutron-energy range can be designed and can compete economically with fossil-fuel power within the next decade. (auth)

15298 DESIGN OF THE AMERICAN HIGH-TEMPERATURE REACTOR. László Rétvári (Heat Planning Commission). Energia és Atomtech., 14: 40-3(Jan. 1961). (In Hungarian)

Although it represents only the prototype stage, the HTGR has been designed for a relatively high heat-generating capacity with improved steam characteristics. It is hoped that a high burnout will be obtained from the sturdily constructed, reliable fuel elements, presenting a safe and efficient system. The maintenance problems are simplified by having only a low-level activity in the primary system. Comparing the operational parameters of the HTGR, the German BBC-Krupp and the British Dragon reactors, it is noted that all three of these high-temperature reactors use highly or completely enriched fuel, take advantage of the U-233 or the Th-232 formed, are designed for a high burnout, and have a fuel temperature higher than 1000°C resulting in a gas outlet temperature of about 800°C. In this latter respect they present a considerable improvement over the British gas-cooled reactors with gas outlet temperature of 400°C. The net yield of the HTGR will be about 35% which compares favorably with the 20 to 25% yield of the current British power reactors. The new high temperature reactor systems are of great interest to countries which recently became interested in the utilization of nuclear energy. (TTT)

15299 CAVERNS AS NUCLEAR POWER REACTOR CONTAINERS. FURTHER EXPERIMENTAL RESULTS. T. Leardini and M. Cadeddu (SADE, Venice). Energia nucleare (Milan), 8: 93-8(Feb. 1961). (In English)

Tests of cavern containment for nuclear power reactors are described. The effect of a major loss of coolant from a pressurized water reactor is investigated in a cavern whose walls are coated with an epoxy resin enamel. Results are shown for the thermal shock endurance of the enamel. The tightness of the cavern walls under steam condensing conditions is tested. Tests on rapid pressure suppression by spray water are reported. The efficiency of spray water as a method for rapid temperature and pressure decrease is investigated. (auth)

15300 PERFORMANCE OF NUCLEAR ROCKET FOR LARGE-PAYLOAD, EARTH-SATELLITE BOOSTER. Eldon W. Sams (Lewis Research Center, Cleveland). J. Aero/Space Sci., 27: 481-93(July 1960).

The performance of single-stage, heat-transfer-type nuclear rockets using either dispersed-fuel-in-graphite reactors or tungsten-fuel-element-in-BeO reactors with hydrogen as propellant is evaluated for large-payload, earth-satellite missions. The reactor and nuclear rocket performance is presented for several reactor sizes and for a range of reactor operating conditions to show the effect of important reactor variables and to predict payload versus gross weight characteristics for nuclear rockets of this type. Due to the basic differences and assumptions for the two types of reactors, a close comparison of performance is avoided. For the assumptions used, however, the study shows that the BeO-tungsten reactor must operate at temperatures about 10 per cent higher than the graphite reactor for the same performance. The graphite reactor also offers lower uranium investments and reduced system complexity. The BeO-tungsten reactor probably permits higher operating temperatures, although actual performance for either system is dependent on materials temperature limits which, as yet, are unestablished. Using either type of reactor, for the assumed range of temperatures, the study indicates nuclear rocket payloads up to about 10 per cent of the gross weight. (auth)

15301 SURVEY OF POWER REACTORS. Rolf Berndt. Kerntechnik, 3: 33-6(Jan. 1961). (In German)

The conditions which a power reactor should fulfill are listed, and various types of power reactors are described. For graphite-moderated, natural uranium reactors the temperature and pressure gradients and their effects on construction are discussed. The addition of nuclear superheating to Soviet pressurized water, graphite moderated reactor is discussed. For pressurized water and boiling water reactors, possible future developments are considered. The latest developments in the area of high temperature reactors are indicated. (tr-auth)

15302 SOME SPECIAL PROBLEMS IN THE DRAGON PROJECT. K. Hintermann. Neue Tech., 2: No. 12, 3-8 (Dec. 1960). (In German)

Some general features of the High Temperature Gas Cooled Reactor are indicated. Some special problems are described, and the solutions planned are discussed. Topics discussed include safety problems, confinement of fission products, the primary coolant circuit, coolant purification, mass transport, "Zenith" kinetic experiments, heat transfer experiments, and irradiation research. (J.S.R.)

15303 CIVILIAN POWER REACTOR PROGRAM. Index to Ten-Year Civilian Power Reactor Program (TID-8518 Series). (Atomic Energy Commission, Washington, D. C.). 1961. 13p.

A subject index has been prepared for reports describing the technology of eight reactor concepts under development in the Civilian Power Reactor Program. The reports were issued as separate books of TID-8518. (B.O.G.)

15304 MARS—A ONE-DIMENSIONAL DEPLETION CODE FOR BOILING-WATER REACTORS. K. Arai, K. Matsuoka, and S. Terasawa (Central Research Lab., Hitachi Ltd., Tokyo). p.67-93 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

MARS is a one-dimensional, modified one-group depletion code for iterating the effect of a boiling moderator and coolant, programed for the IBM 650 and the IBM 704. It provides a means of studying the neutron flux, the power level, the void distribution, and the related build-up, and depletion of materials at different stages in the lifetime of a reactor, in conjunction with the shuffling of fuel elements. One-dimensional depletion codes have already been programed for the IBM 704, e.g., CANDLE and BOX; however, they are not suitable for analyzing the problem of boiling-water reactors because they cannot take into account the effect of variable water density in the reactor. In group constants calculation, heterogeneous effects are treated as the fuel self-shielding factors and the void dependence is treated as changes of the water density. Then, using these

group constants, flux and void distributions are computed. Criticality may be maintained by varying the control-rod absorption cross-section, mesh-wise in the axial direction and region-wise in the radial direction. The neutron flux is normalized to a specified power and assumed to be constant for a specified duration. Isotopic concentrations are computed at the end of each time-stage using the power-normalized flux. When criticality cannot be maintained, fuel rods can be shuffled in not more than 10 batches. A maximum xenon calculation is optional at each time-stage. MARS-I using the "forward" method is for the IBM 650, MARS-II using the "backward" method is for the IBM 650, and MARS-III using both methods is for the IBM 704. (auth)

15305 AN EXAMPLE OF THE USE OF CODES IN A POWER REACTOR DESIGN. P. Bacher (Centre d'Etudes Nucleaires, Saclay, France). p.99-110 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960." (In French)

The physical study of a power reactor design comprises several stages: firstly, the investigation of what is necessarily an immensely wide field, owing to the large number of parameters involved; secondly, once the salient features of the design have been approximately determined, a piecing-together of the information obtained; finally, the study of certain points of detail, such as flux peaks, local geometrical effects, etc. The first part deals with the codes used at Saclay for the preliminary study of graphite and natural uranium power reactors (e.g., computation of lattices, critical states and fuel cycle). The second part describes a code which is designed to piece together the results of the preceding studies. In the third part some examples are given of the use of more complex codes for the study of particular problems. (auth)

15306 AUTOMATIC OPTIMIZATION STUDIES. G. Black (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). p.507-11 of "Codes for Reactor Computations. Proceedings of the Seminar on Codes for Reactor Computations held at Vienna, April 25-29, 1960."

Automatic computing methods for the optimization of a function of many non-linear parameters, with particular reference to nuclear power station design and performance, are described. (auth)

15307 CONTROL OF NUCLEAR REACTORS AND POWER PLANTS. Second Edition. M. A. Schultz. McGraw-Hill Series in Nuclear Engineering. New York, McGraw-Hill Book Company, Inc., 1961. 469p. $12.50.

A fundamental approach to reactor control and engineering is presented. Mathematical presentations are given of reactor responses to various forcing functions and of control-loop responses to various transients. Reactor transfer functions are derived. Details of special reactor components, and operations which affect these elements, are studied. Basic problems of plant response and programming are examined. Servomechanisms and reactor simulators are discussed. Attention is given to control aspects of boiling and homogeneous reactors, as well as pressurized water reactors. (The first edition of this book was abstracted in NSA, Vol. 10, as abstract no. 8672.) (T.F.H.)

15308 A METHOD OF TREATING UNDER LOW PRESSURE A PROPORTION OF A LIQUID CIRCULATING UNDER HIGH PRESSURE IN A CLOSED CYCLE. (to Sulzer Freres, Societe Anonyme). British Patent 859,277. Jan. 18, 1961.

A method is given for treating under low pressure a proportion of a liquid circulating in a high-pressure closed cycle, such as water which is to be purified for a pressurized water reactor plant. In this method, some of the high-pressure liquid is passed into a lock chamber which is then closed pressure-tight, and the trapped liquid is expanded. After processing under low pressure in a treatment plant, the liquid is passed into the lock chamber, pressurized, and passed back into the high-pressure system. The advantage of the method is that it avoids the need of large amounts of energy that would be required to pump the treated liquid into the high-pressure system, such as in continuous treatment of the high-pressure liquid. (D.L.C.)

Production Reactors

15309 (HW-65548) PROCESS IMPROVEMENT TRANSITION AUTHORIZATION #11-I INSTALLATION OF VAN STONE SEAL INSERTS–F REACTOR. A. Russell (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 7, 1960. Contract AT(45-1)-1350. 6p.

A Van Stone seal insert used to reduce F Reactors' production losses associated with rear Van Stone and nozzle gasket leaks is described. The seal inserts are designed to be installed in the rear nozzle of each process tube. The procedure for fitting the Van Stone seal inserts onto each tube is given. (M.C.G.)

15310 POWER CONVERSION STUDIES. HANFORD NEW PRODUCTION REACTOR. (United States. Congress. Joint Committee on Atomic Energy). Mar. 1961. 389p.

A compendium of unclassified literature and correspondence relating to the economic feasibility of the Hanford NPR is presented which was prepared by the staff of the Joint Committee on Atomic Energy. Both electric power generation and production of special nuclear materials are considered. Reports on power conversion studies and on adding electric power generating equipment to NPR are reviewed. (D.L.C.)

Research Reactors

15311 (CF-59-12-24) STATUS REPORT OF THE SOLUBLE POISON SHIM CONTROL FOR THE HFIR. H. A. McLain (Oak Ridge National Lab., Tenn.). Dec. 15, 1959. 40p.

A number of chemicals were investigated for their possible use as a soluble poison for the HFIR shim control. Boric acid is the usual material proposed for this type of application, and it appears to be satisfactory for a high flux reactor with a heavy water reflector containing the soluble poison. Other boron compounds such as potassium metaborate were considered. Cadmium sulfate and the rare earth sulfates were also considered, but they show limitations in their worth and exhibit inverse solubilities with temperature. Placing a soluble poison in a relatively narrow region between the core and a beryllium reflector does not appear to be promising because of solubility limitations. A mixture of boric acid and potassium metaborate may work, but it introduces a residual activity problem due to the potassium. A preliminary flowsheet was drawn and some heat generation calculations in Zircaloy-2 and boric acid poison solution were made. (auth)

15312 (UCRL-4919(Rev.)) THE LIVERMORE POOL TYPE REACTOR (LPTR). John B. Radcliffe, Jr., and Ernest E. Hill (California. Univ., Livermore. Lawrence Radiation Lab.). Revised Nov. 1960. Contract W-7405-eng-48. 56p.

The LPTR is a tank-type thermal, heterogeneous research reactor facility at the Livermore site. The light-

water moderated and cooled reactor core will generate a peak flux in excess of 10^{13} n/cm^2-sec at an operating power of 2 Mw. Access to the flux is provided by a variety of experimental facilities, including 6 horizontal beam tubes (the largest almost 13 in. in diameter), 2 thermal columns (one largely removable to provide a high fast flux within an associated cave-like irradiation cell), and 2 pneumatic tubes. These, combined with a number of other irradiation ports, are intended to make the reactor a versatile, flexible research tool, available to all groups within the LRL research program. The LPTR design calls for a core containing roughly 4 kg of U^{235} in fuel elements of the MTR type, arranged within a 5 by 7 element grid configuration which also provides space for beryllium reflectors. Aluminum is the primary structural material in the core, and in the closed circuit cooling system. A compact biological shield is achieved through use of magnetite concrete. The reactor core is controlled by 4 boron-carbide shim safety rods and a stainless steel regulating rod, with conventional console control instrumentation. Total containment is emphasized in the reactor housing—an all-steel, air-tight structure which is connected to adjacent labs and the control room by an air lock. (auth)

15313 REACTIVITY WORTH OF THE CENTRAL FUEL ELEMENT IN THE BULK SHIELDING REACTOR-I. G. de-Saussure, K. Henry, and R. Perez-Belles (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 9: 291-8(Mar. 1961).

The reactivity worth of a plate-type fuel element at the center of a critical lattice of such elements was experimentally determined by the pulsed-neutron method. This value has not been previously established because it is too large to be obtained by conventional inhour techniques. The value obtained for the Bulk Shielding Reactor-I Loading No. 78 was $\Delta\rho = 6.1 \pm 0.5$ dollars. Additional measurements of a configuration in which the central element was replaced by an element containing either one-half or three-quarters of a normal fuel element loading are discussed. (auth)

15314 FNR SHIM-SAFETY ROD DEFORMATIONS. C. W. Ricker and W. R. Dunbar (Univ. of Michigan, Ann Arbor). Nuclear Sci. and Eng., 9: 410-11(Mar. 1961).

Analyses of deformed shim-safety rods in the Ford Nuclear Reactor indicated the presence of a H, O, and N mixture with no significant concentration of He. The presence of water in the rod indicates that the deformation is caused by radiolytic dissociation. This is supported by the presence of H in the shim rods, but the possibility of attaining pressures capable of expanding the shim rods is still subject to question. (N.W.R.)

15315 FUEL ELEMENT ASSEMBLAGE FOR NUCLEAR REACTORS. (to A C F Industries, Inc.). French Patent 1,210,962. Oct. 5, 1959.

Fuel element assemblies in a research reactor, moderated e.g. by heavy water, are described. Each assembly consists of a tube-shaped lower part, containing the nuclear fuel and fitting in a complementary hole in a bottom grid, and a detachable upper part, comprising an empty tube whose top is closed by a heavy stopper. Most of this upper part is inserted in a channel of an upper biological shield. A special gear is provided in a thick-walled container which enables the detaching of the upper part of the said assembly, removal of the spent fuel from the reactor core and its transportation e.g. to a cooling pond, and the placing of new fuel in the core. (NPO)

15316 FASTENING AN IRRADIATION CONTAINER IN THE EXPERIMENTAL TUBE OF A REACTOR. (to Commissariat a l'Energie Atomique). German Patent DAS 1 078 245. Mar. 24, 1960. (In German)

A material to be activated in the irradiation channel of a reactor must be placed in a container which forms a unit with the channel seal so that irradiation shielding is guaranteed. A device is proposed which has the special advantages of remote control and air-tightness. The introduction of cooling circuits is possible without special machining. A sketch of the device is presented. (J.S.R.)

15317 (ARF-3119-13) SCAVENGING OF PARTICULATE MATTER IN CONNECTION WITH NUCLEAR-POWERED SHIPS. Final Scientific Report. J. Rosinski (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 29, 1960. Contract AT(11-1)-586. 49p.

The work carried out over a 2½-yr period on the scavenging of radioactive particles which might be released by the reactor system of a nuclear-powered ship is summarized. Two types of dispersions were considered: aerosols and hydrosols. Radioactive aerosols were scavenged by heterogeneous coagulation with solid and liquid aerosols produced within the radioactive aerosol cloud. Liquid or highly hygroscopic particles, which can be classified as solid particles with liquid films on their surfaces, were found to be the most effective scavengers. A system of fine water spray and hydrolysis products of silicon tetrafluoride was found to be suitable for field application. Scavenging of radioactive cations, anions, and colloids of corrosion and fission products was studied in substitute ocean water, natural ocean water, and natural harbor water. A scavenging system composed of $KMnO_4$ and ferrous salts successfully removed most of the radioisotopes. $Fe(OH)_3-MnO_2$ hydrate adsorbed and absorbed radioactive species, thus transferring them from a liquid to a solid phase. Addition of Floc 111 to the system improved sedimentation. The $KMnO_4-FeSO_4-$Floc 111 system was found to be suitable for field application. (auth)

15318 (ARF-3184-5) SCAVENGING OF RADIOACTIVE AEROSOLS IN CONNECTION WITH NUCLEAR-POWERED SHIPS. Monthly Status and Progress Letter No. 5, Covering Month of January. John Rosinski (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 17, 1961. Contract AT(11-1)-578. 8p.

Scavenging tests for iodine aerosols using untreated, activated carbon were continued. Work completed on the suppression of aerosol formation from fuel elements is summarized. Sodium was used in the screening tests to find promising scavengers for barium, lanthanum, and strontium. An analysis was made of the results of neutralizing silicon tetrafluoride scavenging systems with 1.0N sodium hydroxide. (B.O.G.)

15319 (NYO-9577) THE REMOVAL OF STRONTIUM AND CESIUM FROM NUCLEAR WASTE SOLUTIONS BY FOAM SEPARATION. Final Report. E. Schonfeld, R. Sanford, G. Mazzella, D. Ghosh, and S. Mook (Radiation Applications Inc., New York). July 29, 1960. Contract AT(30-1)-2093. 143p.

The removal of cesium, strontium, and rare earth cations from dilute aqueous solutions by adsorption on foam surfaces was studied. The primary objective in the study was to determine the technical feasibility of a foam separation process for the removal of specific nuclides from nuclear process streams. Foam separation takes advantage of the concentration difference existing between the surface layers and the bulk regions of solutions containing surface active solutes. Enrichment of non-surface active materials, such as cations and anions, at the air-water interface may be achieved by complexing these materials into a surface active form. Equilibrium surface adsorption coefficients, Γ/C, were determined for cesium, strontium, and samarium in 10^{-5}M solutions combined with various surface active agents. Among those studied, the foaming agents that showed best selectivity for strontium and samarium were the amino polycarboxylic acids. Promising cesium enrichments were obtained using a combination of an amino polycarboxylic acid and sodium tetraphenyl boron. The equilibrium surface adsorption was found to depend upon the type of foaming agent, the foaming agent concentration, the metal ion concentration, pH, the inert salt ($NaNO_3$) concentration, and the temperature. Continuous separation of strontium and samarium from 10^{-5}M aqueous solutions containing 1M sodium nitrate was studied in experimental countercurrent foam columns. Decontamination values of 400 to 700 were demonstrated for strontium and samarium in a single pass through a three foot foam column, with corresponding volume reductions of 100 to 400 without evaporation. Decontamination values for strontium in the order of 10^4 to 10^7 were observed in a four column series set up. A study of the effect of the continuous column operating variables, such as liquid and gas flow rates, foam bubble size, column dimensions and temperature, on the separation efficiency was conducted. It was concluded that the degree of metal ion separation is primarily dependent on three factors: the equilibrium distribution coefficient, the ratio of the surface area generated to the liquid feed rate, and the height of the foam column. The experimental results indicate that the performance of a continuous countercurrent foam column can be quantitatively described by a Kremser or Colburn type of relationship, commonly employed in the design of conventional mass transfer unit operations. Relationships of this type were derived from a mathematical analysis of a foam column model. (auth)

15320 (TID-11048) TREATMENT OF RADIOACTIVE WASTES BY CHEMICAL PRECIPITATION AND ION EXCHANGE AT LOS ALAMOS, N. MEX. J. P. Hutchinson and C. W. Christenson (Los Alamos Scientific Lab., N. Mex.). [nd]. 18p.

A description is given of the plant designed for the concentration and treatment of radioactive waste solutions. A flow sheet illustrates the standard operating procedures. During the hold-up time the radiation level is decreased by 50% every 13 days. A chemical treatment was introduced to concentrate the gross gamma radioactivity in the sludge, which is mixed with concrete for final disposal. The supernatant fluid in the settling tank is pumped through two columns containing 50 cu ft of cation exchange resin, each, then discharged in a canyon. Methods are described for regenerating the ion exchange resins, and for treating the regenerating fluid. Radiation hazards to operating personnel were reduced by a combination of chemical treatment facilities, shielding of major units by burial, and a greatly reduced operating and maintenance time requirement. Typical operating and regenerating results are included. (B.O.G.)

15321 (WIN-121) QUARTERLY PROGRESS REPORT [ON WASTE DISPOSAL AND PROCESSING], OCTOBER 1,

1960–December 31, 1960. (National Lead Co., Inc. Winchester Lab., Winchester, Mass.). Feb. 1961. Contract AT(49-6)-924. 40p.

Work was continued in analytical development, mill effluent decontamination, mill dust evaluation, leaching of radium bearing mill tailings, and on patterns of area contamination from mill operations. Procedures are described for the determination of actinium isotopes in mill effluent, the determination of Ra^{228}, the determination of Ra^{223} by ion exchange separation and counting daughter Pb^{211}, and the determination of Pb^{210} in soil. (C.H.)

15322 THE TREATMENT OF RADIOACTIVE WASTES ORIGINATING IN ISOTOPE LABORATORIES. Daniel Vodros (Public Health and Epidemics Station). Energia és Atomtech., 14: 43-7(Jan. 1961). (In Hungarian)

As practically the whole amount of radioactive materials used in medical and research laboratories will ultimately become waste, they present a serious disposal problem. International standards have been established for the maximum allowable levels to be released in the air and in the atmosphere. Special attention must be given to materials with a long half-life and to those which tend to become enriched in the body. The bone-seeking α-emitting Ra is thus one of the most dangerous materials. This group includes also Sr-90, Sr-89, I-131, and Cs-137. Whenever possible the short and long half-life materials must be stored separately. The combustible solid waste is best burned, retaining the active ashes and other combustion products; the liquid wastes may be concentrated, diluted, precipitated, distilled or treated with ion-exchange resins. The highly active concentrated residues should be stored underground in stainless steel containers or they may be integrated in cements or ceramic materials from which they cannot be easily leached out. The cost of the various disposal methods are as follows: precipitation, $\$1/m^3$; distillation, $\$20/m^3$; ion exchange, $\$1.25/m^3$; treatment with vermiculite, $\$1/m^3$. The relative efficiency of these methods remains to be evaluated yet. (TTT)

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